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RCRA MONITORING PLAN

U.S. Industrial Chemicals Co.

Tuscola, Illinois

Bruce S. Yare and Associates, Inc.

Consulting Groundwater Geologists

24 South 77th Street, Belleville, Illinois 62223

RCRA MONITORING PLAN

U.S. INDUSTRIAL CHEMICALS CO.

TUSCOLA, ILLINOIS

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STATE OF ILLINOIS

Bruce S. Yare and Associates, Inc.

24 South 77th Street, Belleville, Illinois

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INTRODUCTION

Bruce S. Yare and Associates, Inc. were retained by the U.S. Industrial Chemicals Co. to evaluate ground-water conditions at the Tuscola, Illinois plant and design a RCRA monitoring plan for its hazardous waste management facility.

The plant, operating since 1953, produces a variety of organic and inorganic chemicals. Ethane, propane, butane and other natural gas constituents are extracted and liquified or used to make petrochemicals in the south production area (Figure 1). Nitric, phosphoric and sulfuric acids were once produced in the north area, but now only sulfuric acid is made there. Solid waste from phosphate rock processing, primarily gypsum, is stored on the northern edge of the plant property. Power plant fly ash, which is exempted from RCRA regulation, is presently disposed in several fill areas north of the acid plant.

Two hazardous waste management facilities are found at the site: 1) a hazardous material storage building and 2) an unlined impoundment containing low pH waste water. The impoundment, built in 1954 as part of the plant's waste water treatment facility, is the only hazardous waste management facility required to have a ground-water monitoring plan as defined by regulations promulgated May 19, 1980. Wastes in the impoundment are classified as hazardous on the basis of corrosivity only.

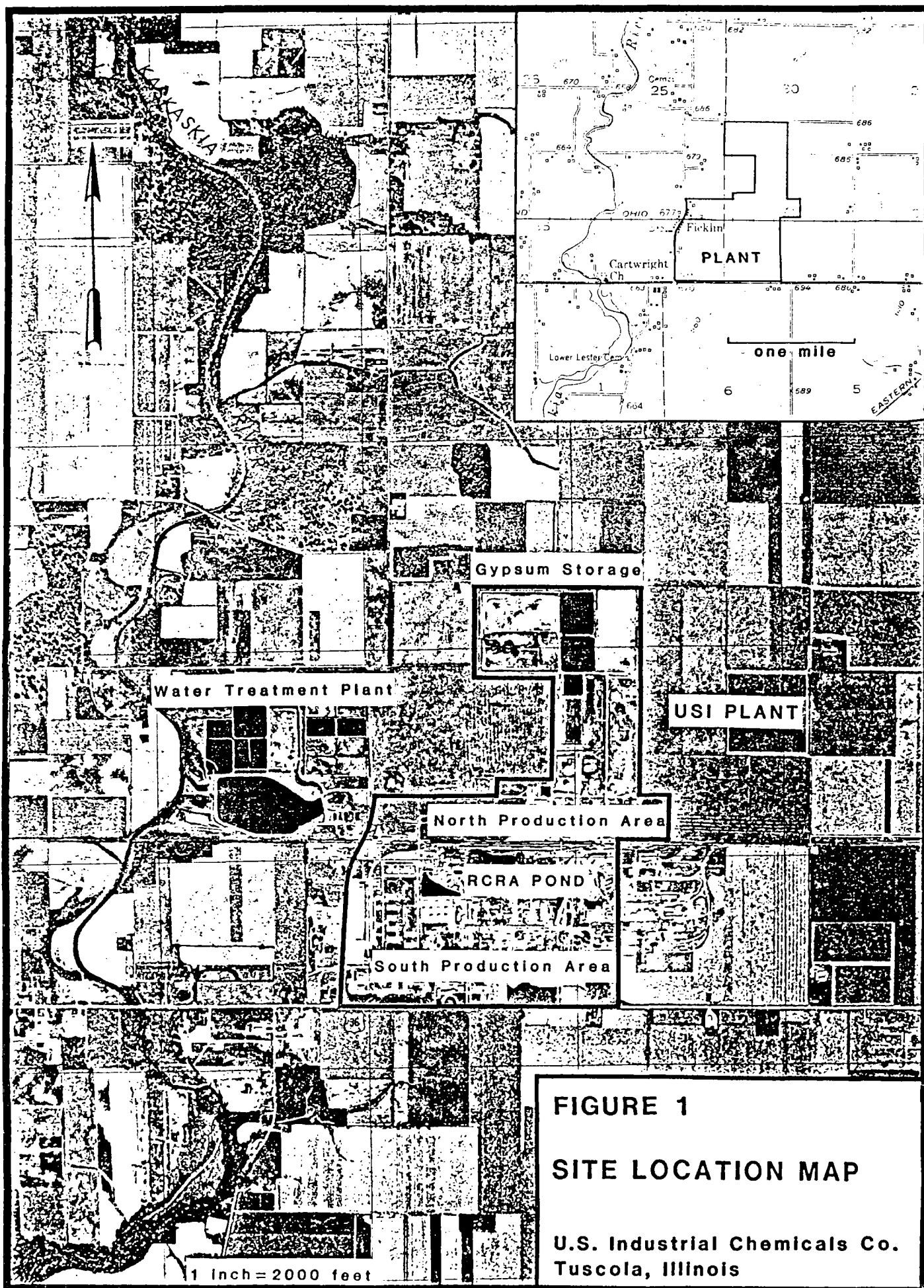


FIGURE 1

SITE LOCATION MAP

U.S. Industrial Chemicals Co.
Tuscola, Illinois

REGIONAL HYDROGEOLOGY

Unconsolidated Aquifers

All but the southern tip of Illinois is mantled with unconsolidated glacial sediments laid down directly by ice sheets (till) or deposited in front of the ice by meltwater streams (outwash) or glacial lakes. Till is the most common deposit, consisting primarily of clay and silt with thin, discontinuous sand lenses. In the Tuscola area, low-yield water supplies suitable for domestic and farm use are obtained from the till by drilled wells tapping sand lenses no more than 5 to 10 feet thick. Where sand lenses are thin or absent, large-diameter wells are needed to obtain water from the till by slow leakage. Boring logs from the plant area indicate only a few isolated, lenticular, silty sand lenses occur in the till, generally at depths greater than 70 feet (Appendix 1).

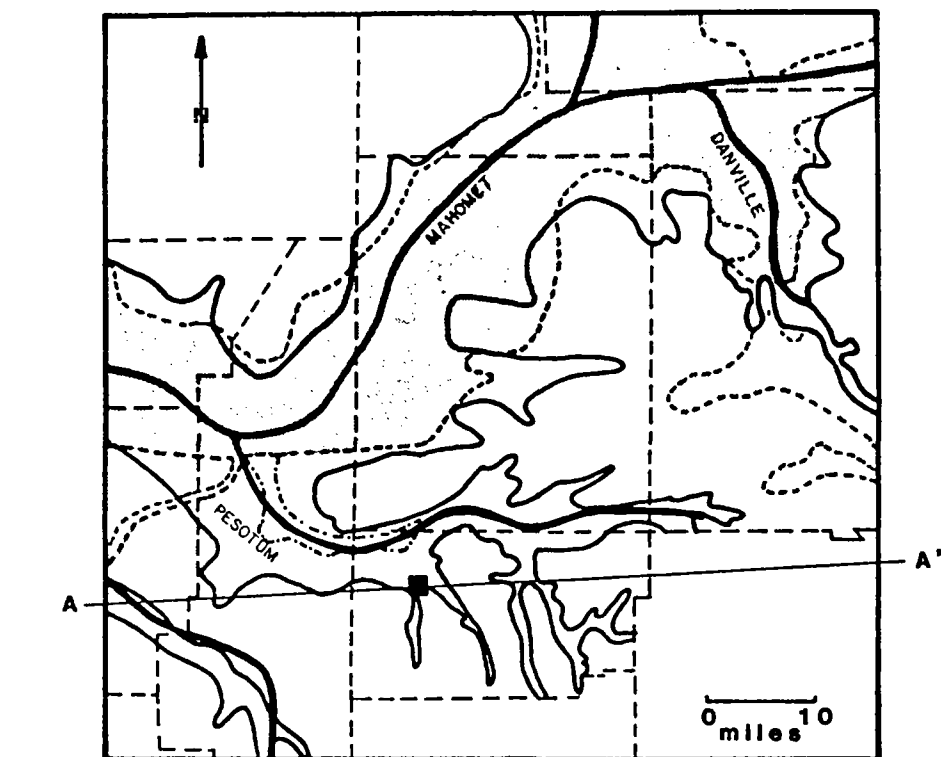
Sand and gravel outwash deposits in buried bedrock valleys form prolific aquifers throughout east-central Illinois. The 500 ft. bedrock elevation contour roughly defines the areal extent of these valleys, which were formed on the bedrock surface by stream erosion (Figure 2). A major east-west bedrock valley, the Pesotum Valley, occurs north of the plant and one of its northwest-trending tributaries appears to occur under and south of the plant site.

However, no wide-spread, prolific aquifers are reported in the Pesotum Valley or its tributaries (Selkregg and Kempton, 1958, Visocky and Schicht, 1969).

Past efforts to develop large-capacity wells in the area of the plant indicate no prolific aquifers occur in the immediate vicinity. From 1937 to 1945 nearly twenty test borings and a number of unsuccessful production wells were installed to develop a ground-water supply for the Panhandle Eastern compressor station located southwest of the plant. In 1945, Panhandle Eastern abandoned its attempts to obtain a ground-water supply and developed a surface-water supply from the Kaskaskia River. Borings drilled to bedrock at the plant also indicate that significant accumulations of permeable sand and gravel do not occur in the area (Appendix 1).

Bedrock Aquifers

Most of the shallow bedrock in the vicinity of the Tuscola plant is Pennsylvanian or Mississippian shale (Appendix 1). These formations are not important aquifers because of their low permeability and poor water-quality. A major structural uplift in the bedrock several miles east of the plant, the LaSalle Anticline, brings permeable Silurian and Devonian limestone and dolomite units close to the ground surface (Figure 2). Here, limited supplies of slightly mineralized water can be developed from the bedrock aquifer. The city of Tuscola, located on the west limb of the LaSalle Anticline, develops some of its water supply from Silurian dolomites.



LEGEND



PLANT LOCATION



BEDROCK VALLEY AXIS



500 ft BEDROCK ELEVATION
CONTOUR

OCCURRENCE OF SAND & GRAVEL AQUIFERS



WIDESPREAD
HIGHLY PERMEABLE



SCATTERED and DISCONTINUOUS
VARIABLE PERMEABILITY



SAND & GRAVEL DEPOSITS
GENERALLY ABSENT



POTENTIAL AQUIFER

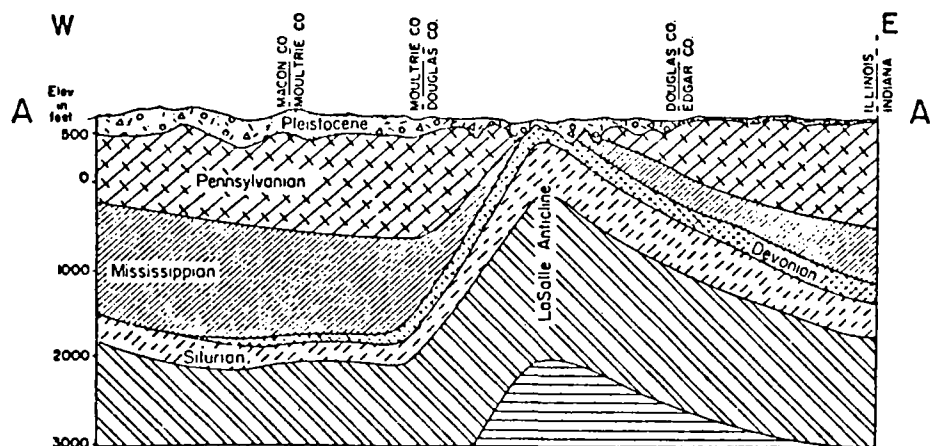


FIGURE 2

REGIONAL HYDROGEOLOGY

U.S. Industrial Chemicals Co.
Tuscola, Illinois

Ground-Water Quality

Data from public records allow only a partial characterization of regional ground-water quality because of the few wells sampled and limited number of analysed constituents. Table 1 is a summary of ground-water quality data for wells in Township 16 N, Range 8 East. A few wells in Township 16 N, Range 7 East are also included in this summary. On the basis of these data, ground water in the region is hard, alkaline, high in total dissolved solids and contains objectional amounts of iron. Chloride concentrations are very low except in shallow wells. Average concentrations of the constituents are as follows: Iron, 3.5 mg/l; Chloride 12 mg/l, Alkalinity 331 mg/l; Hardness, 271 mg/l and Total Dissolved Solids, 463 mg/l.

Waste Disposal Impact

The Tuscola plant is located in a region where hydrogeologic conditions are generally favorable for hazardous waste disposal (Cartwright and others, 1981). Glacial drift in the area, composed primarily of clay and silt, is 100 to 300 feet thick and rests on shale bedrock. Only small quantities of ground water are available from isolated sand lenses in the drift and shallow bedrock is not normally tapped for water. Although the water table is fairly close to land surface, the region is still suited for waste disposal because of the low hydraulic conductivity of the glacial drift. However, disposal operations could adversely effect sand and gravel

Table 1. Summary of Regional Ground-Water Quality Data. U.S. Industrial Chemicals Co., Tuscola, Illinois. (Data from Illinois State Water Survey files for T16N, R7&8E. All concentrations are in milligrams per liter).

	WELL DEPTH (feet)		
	<u>0 to 50</u>	<u>50 to 100</u>	<u>200 to 300</u>
Iron, Total as Fe			
Mean	2.4	3.0	4.0
Range	Tr - 8.9	0.2 - 13	0.0 - 14.7
Std. Dev.	2.8	2.5	4.1
Chloride, as Cl			
Mean	33	10	4
Range	3 - 81	0 - 48	1 - 9
Std. Dev.	26.9	13.5	2.2
Alkalinity, as CaCO ₃			
Mean	249	362	382
Range	40 - 480	122 - 648	272 - 508
Std. Dev.	190	154	66
Hardness, as CaCO ₃			
Mean	229	257	256
Range	68 - 587	164 - 490	172 - 358
Std. Dev.	206	87	69
Total Dissolved Solids			
Mean	493	451	408
Range	103 - 878	328 - 780	304 - 573
Std. Dev.	253	105	76
No. of Samples	11	28	19

aquifers in buried bedrock valleys or near-surface dolomite aquifers along the LaSalle Anticline.

Throughout the area, the potential for subsurface waste disposal by injection wells is considered excellent (Bergstrom 1968). Adverse hydrogeologic impact is limited by the presence of near-surface low permeability shales capping permeable formations containing highly mineralized water. For over ten years, USI and neighboring Cabot Corporation have used injection wells for acidic waste-water disposal in the Eminence-Potosi Dolomite.

SITE HYDROGEOLOGY

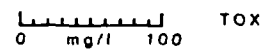
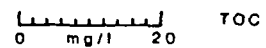
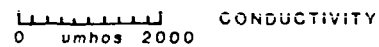
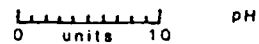
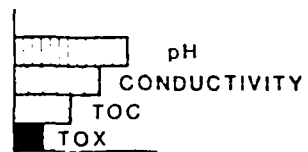
Field Investigation

From August 31 to September 9, 1981, seven 2-inch diameter observation wells were installed at the Tuscola plant (Figure 3). Because a preliminary evaluation of ground-water conditions indicated a limited potential for impact by the RCRA impoundment, the wells were located over as wide an area as possible in order to define areal distribution and characteristics of subsurface materials, general ground-water flow patterns and existing ground-water quality.

The wells were installed by using a CME 55 hollow stem auger to drill a borehole 31 to 32 feet deep. Soil samples were collected at regular intervals with split barrel or Shelby tube samplers so that subsurface materials could be accurately described. After pulling the augers, twenty feet of machine-slotted PVC well screen and ten to fifteen feet of riser pipe were set in the borehole (Appendices 2 and 3). Flush threaded screen and casing were used to avoid sample contamination by PVC cleaner or glue. The annulus was backfilled with clean quartz sand to a point several feet above the top of the screen and then filled to grade with cement/bentonite grout. An attempt was made to develop the wells by air agitation but yields were too low to sustain repeated surging.

EXPLANATION

OW-1 ● Well Number
622.2 Water-Level Elevation



WELL	ELEVATION	
	GRADE	M.P.
OW-1	671.6	674.8
OW-2	678.3	681.5
OW-3	682.5	685.7
OW-4	691.7	695.0
OW-5	693.9	697.0
OW-6	690.6	693.6
OW-7	688.5	691.7

1 inch = 1000 feet

KASKASKIA RIVER
elevation 650 ft.

WATER TREATMENT PLANT

OW-1

OW-1

OW-1

NOTES: 1) Oct. 20, 1981 water quality data.

2) Estimated water-level elevation in a dug well adjacent to OW-2 is 672 ft.

As a result, several of the wells are poorly developed and yield very turbid water.

The soils encountered during drilling were uniform across the site - topsoil underlain by 10 to 15 feet of light brown, gravelly clay resting on a light gray, gravelly clay (Appendix 3). These clays are part of the 100 to 200 feet thick glacial tills at the site (Appendix 1). Occasionally, thin lenses of fine, silty sand were found but there were no thick, laterally-extensive sand layers. SKS and Associates, Inc. of Decatur, Illinois analysed selected soil samples for grain size, moisture content, dry density, permeability and cation exchange capacity (Appendix 4). These samples, collected from approximately the same depth in widely separated borings, represent the range of soil materials encountered at the site.

Laboratory tests of soil samples from OW-2, OW-5 and OW-6 indicate the brown and gray tills are composed primarily of clay and silt sized particles with a relatively low moisture content and extremely low permeability (Table 2). Vertical permeability of the brown clay ranges from 2.4×10^{-8} to 7.1×10^{-9} cm/sec and the gray clay permeability ranges from 1.1×10^{-8} to 7.1×10^{-9} cm/sec. Cation exchange capacity of these soils is high, ranging from 80 to 85 meq/100 gram for calcium, and soil pH is 7.5 to 8.0.

To measure the horizontal permeability of the tills at the site, falling head permeability tests were run on wells OW-2, OW-5

Table 2. Unconsolidated Sediment Physical Characteristics.
U.S. Industrial Chemicals Co., Tuscola, Illinois.

LABORATORY TESTS

<u>Well</u>	<u>Sample Depth (feet)</u>	<u>USCS Class</u>	<u>Grain Size</u>		<u>Moisture Content (%)</u>	<u>Dry Density (pcf)</u>	<u>Vertical Permeability (cm/sec)</u>
			<u>Coarse (%)</u>	<u>Fine (%)</u>			
OW-2	7.5-9.5	CL,brown	26	74	14	123.0	7.1×10^{-9}
	21-23	CL,gray	33	67	14	122.0	1.1×10^{-8}
OW-5	7.5-9.5	CL,brown	31	69	14	123.0	3.2×10^{-9}
	23-25	CL,gray	32	68	13	125.0	2.0×10^{-8}
OW-6	8-10	CL,brown	29	71	14	123.0	2.4×10^{-8}
	21-23	CL,gray	28	72	14	123.0	7.1×10^{-9}

FIELD TESTS

Well	Screened Interval (feet)	Horizontal Permeability			
		Winterkorn & Fang			Schmidt
		$k_h = k_v$	$k_h = 100 k_v$	$k_h = 1000 k_v$	$k_h = k_v$
OW-2	10.9-29.9	1.6×10^{-5}	2.2×10^{-5}	2.6×10^{-5}	1.2×10^{-5}
OW-5	10.2-30.1	0.5×10^{-5}	0.7×10^{-5}	0.8×10^{-5}	0.35×10^{-5}
OW-6	10.0-30.0	1.3×10^{-5}	1.9×10^{-5}	2.2×10^{-5}	0.95×10^{-5}

and OW-6. In this type of test, the well is filled to the top with water and, after the water source is shut off, the decline in water level with time is measured. The permeabilities derived from this data primarily reflect the horizontal permeability of the most transmissive soil unit or fracture zone in the test interval. In the glacial drift these transmissive units are most likely lenticular sands too thin to be observed regularly during soil sampling or zones of secondary porosity (fractures, etc.) in the clays.

Horizontal permeabilities at the site are much higher than vertical permeabilities. This is not unexpected since horizontal permeability (K_h) is generally much greater than vertical permeability (K_v) in unconsolidated sediments because of their deposition in horizontal layers. Calculated horizontal permeabilities range from 0.7×10^{-5} to 2.2×10^{-5} cm/sec. A permeability of 10^{-5} cm/sec is characteristic of silty sand and silt (Freeze and Cherry, 1979). The results of the field permeability tests are summarized in Table 2 and the raw data and analytical procedures are included in Appendix 5.

Ground-Water Flow System

Ground-water flow direction appears to be controlled by topography. The drainage divide between the Kaskaskia River and the Embarras River runs under roughly the eastern third of the plant area (Figure 1). Water-level elevations in OW-6 and OW-7,

(on the east side of the plant, indicate ground-water flow is toward the east (Figure 3). On the other hand, water-level elevations in wells on the west side of the divide (OW-1, 2, 3, 4, and 5) indicate ground-water flow is toward the west.

Because of the extremely slow percolation of water into wells OW-1 and 2 and the absence of wide-spread permeable formations, the ground-water flow system in the vicinity of the RCRA impoundment can not be precisely defined.

(The hydraulic gradient between wells OW-4 and OW-1 can be used to estimate ground-water flow velocity in the vicinity of the RCRA impoundment. For a horizontal permeability of 2.6×10^{-5} cm/sec (0.074 ft/day), a gradient of 0.0055 and an assumed porosity of 35 percent, the ground-water flow rate is defined by:

$$V = \frac{kI}{n}$$

Where: V = velocity, ft/day
k = permeability, ft/day
I = ground water gradient
n = formation porosity

$$V = \frac{(0.074 \text{ ft/day}) (0.0055)}{.35}$$

$$V = 0.0012 \text{ ft/day}$$

$$V = 0.44 \text{ ft/year}$$

This estimate of flow velocity may be unrealistically low.

Ground-Water Quality

(Water samples were collected from all wells on October 19 and 20, 1981. The wells were purged by pumping 4 to 5 gallons

(one casing volume) to waste with a portable peristaltic pump. A quarter-inch polypropylene suction tube was set two to three feet from bottom in each well and left in place. Normal practice calls for purging 3 to 5 well volumes but yields were so low that this procedure would be prohibitively time consuming.

After purging, the wells were sampled with the peristaltic pump. A thoroughly cleaned, clear glass, one-gallon bottle was used as a vacuum flask to collect the sample before it passed through the pump head. This prevented sample cross contamination without having to change the silicone tubing in the pump head. The samples were taken to the plant laboratory where pH and conductivity were measured. Part of the sample was decanted into 500 ml amber glass bottles for total organic carbon (TOC) and total organic halogen (TOX) analyses. TOC was run by the plant laboratory and TOX was determined by Stewart Laboratories of Knoxville, Tennessee.

Specific conductance in the October 20, 1981 water-quality samples ranged from 770 to 1570 micromhos/cm (Figure 3). Most of the sample conductivities were greater than 1000 micromhos/cm. TOC and TOX were at or near detection limits in all but two wells. The TOC concentration of 12 mg/l found in OW-7 is probably due to spillage from an adjacent oil well. The source of the 10 mg/l TOC found in OW-6 is not known. Sample pH was 7.1 to 7.7.

RCRA MONITORING PLANEvaluation of Waste Migration Potential

Migration to Uppermost Aquifer - Little information is available on the water balance in the Tuscola area. For a similar basin in east central Illinois, normal precipitation is 37.2 in/yr (inches per year), runoff is 5.7 in/yr, evapotranspiration is 21.1 in/yr and infiltration is 10.4 in/yr (Schicht and Walton, 1961). The annual ground-water runoff rate for the Kaskaskia River at Arcola, about seven miles south of the plant, is 0.36 cfs/sq mi (cubic feet second/square mile) (Walton, 1965). Ground-water runoff is a good estimate of ground-water recharge (infiltration). A runoff of 0.36 cfs/sq mi is equivalent to a recharge of 232,700 gpd/sq mi (gallons per day square mile).

Available geologic information indicates the RCRA impoundment is underlain by 100 to 200 feet of glacial till containing a few, isolated, lenticular deposits of sand and gravel (Appendices 1 and 3). Near-surface sediments at the site are brown and gray clay with a 14 percent moisture content and an extremely low vertical permeability of 2.4×10^{-8} to 7.1×10^{-9} cm/sec. With abundant rainfall and low-permeability surficial materials, the water table is very close to ground surface, usually four to five feet below grade. As discussed above, the Illinois Geological

(Survey considers this area generally suitable for hazardous waste disposal in spite of the high water table because of the high attenuation capacity and low permeability of the unconsolidated sediments (Cartwright and others, 1981).

There is no distinct, wide-spread aquifer at the site and the till per se cannot be readily used as an aquifer. The permeability of the till is so low that water will not flow into a well fast enough to sustain even limited withdrawals. None of the 2-inch observation wells can be pumped at a rate of more than 0.1 to 0.25 gallons per minute without drying up. Inflow to some of the wells is so slow that it took over thirty days to accumulate 12 feet of water in one of them (Table 3).

(The only water-bearing units in the till that can be considered an aquifer ("a formation....that contains sufficient saturated permeable material to yield significant quantities of water to wells or springs"-Bennett and others, 1972) are the thin, irregularly distributed sand lenses that occur in the till. Where these sand lenses are five to ten feet thick, domestic wells can obtain short-term yields of 10 to 15 gallons per minute (Appendix 6). There are no wells within a thousand feet of the RCRA pond. This is twice the separation required by the IEPA between a hazardous waste site and the nearest well (Cartwright and others, 1981).

(Vertical leakage of significant quantities of poor-quality water from the RCRA impoundment to one of these thick water-bearing sand lenses is unlikely. Although there is some evidence of thick

Table 3. Water-Level Information, U.S. Industrial Chemicals Co., Tuscola, Illinois. (Depth to water in feet below top of casing and elevation in feet above mean sea level.)

<u>Well</u>	<u>Sept. 9, 1981</u>		<u>Oct. 1, 1981</u>		<u>Oct. 19, 1981</u>	
	<u>DTW</u>	<u>ELEV</u>	<u>DTW</u>	<u>ELEV</u>	<u>DTW</u>	<u>ELEV</u>
OW-1	Dry	-	19.8	654.98	12.58	662.20
OW-2	Dry	-	23.0	658.49	21.75	659.74
OW-3	7.36	678.38	7.88	677.86	8.53	677.21
OW-4	7.88	687.17	7.85	687.20	8.16	686.89
OW-5	6.77	690.18	6.74	690.21	6.89	690.06
OW-6	6.75	686.82	6.71	686.86	7.07	686.50
OW-7	24.04	667.65	7.55	684.14	7.66	684.03

sand lenses in the till beneath the site (Appendix 1), they are overlain by more than 70 feet of low-permeability till. The gray till at the site has an average laboratory vertical permeability of 1.3×10^{-8} cm/sec (Appendix 5). Assuming a sand lens exists 65 feet beneath the RCRA impoundment, it would take 4800 years for seepage from the lagoon to reach it (Table 4). The estimated volume of water seeping from the lagoon is 2.3 gallons per day. Due to the vagaries of subsurface conditions, this estimate of travel time and flow volume may be too low. Using the regional recharge rate of 3.9×10^{-7} cm/sec given by Walton (1965), seepage from the impoundment would reach the sand lens at a rate of 67 gpd after 162 years (Table 4).

Based on the estimated vertical seepage rate and volume, the RCRA pond is unlikely to adversely effect water-quality in any underlying sand lens.

Migration to Surface Water - Because of the large contrast between horizontal permeability (10^{-5} cm/sec) and vertical permeability (10^{-7} cm/sec), seepage from the RCRA impoundment should tend to move laterally rather than vertically. The natural discharge point for the shallow ground-water system at the site is the Kaskaskia River, approximately 5000 feet west and southwest of the RCRA pond. Assuming flow beneath the RCRA pond is confined to a segment of the glacial drift 30 feet deep and 1000 feet wide, approximately 80 gpd (gallons per day) of ground water will move from the impoundment toward the Kaskaskia River at a rate of less

Table 4. Estimated Potential for Waste Migration to Uppermost Aquifer. U.S. Industrial Chemicals Co., Tuscola, Illinois.

$$Q = (K_v/m)(\Delta h) A \quad \text{Where: } Q = \text{vertical seepage from pond, gpd}$$
$$K_v = \text{vertical permeability, gpd/sq ft}$$
$$\Delta h = \text{head difference between units, feet}$$
$$m = \text{depth to top of uppermost aquifer, feet}$$
$$A = \text{seepage area of pond bottom, sq ft}$$

$$t = m/K_v \quad \text{Where: } t = \text{seepage travel time}$$

For Laboratory Permeability

$$Q = \frac{0.00028(5)(105,000)}{65}$$

$$Q = 2.3 \text{ gpd}$$

$$t = 65/3.71 \times 10^{-5} \text{ ft/day}$$

$$t = 1.75 \times 10^5 \text{ days}$$

$$t = 4800 \text{ years}$$

For Regional Recharge Rate

$$Q = \frac{0.0083(5)(105,000)}{65}$$

$$Q = .67 \text{ gpd}$$

$$t = 65/0.0011 \text{ ft/day}$$

$$t = 59,090 \text{ days}$$

$$t = 162 \text{ years}$$

than 0.1 ft/day (Table 5). With a 7-day, 10-year low flow of 0.70 cfs, the impact of 80 gpd (0.0001 cfs) is negligible.

Monitoring System

Rather than installing monitoring wells at the limit of the waste management facility, the monitoring wells were installed some distance from it to detect any lateral spread of poor-quality water. This alternative monitoring method is based on: 1) the low potential for vertical or horizontal movement of contaminants, 2) poor background water-quality and 3) the buffering capacity of the calcareous tills at the site.

The RCRA impoundment is classified as a hazardous waste management facility on the basis of corrosivity. The shallow ground-water flow system can act as a natural buffer for any seepage from the pond. Tills at the site are calcareous, soil pH ranges from 7.5 to 8.0 (Appendix 4) and ground-water is very alkaline (Table 1). Any acidic leakage from the pond should be neutralized rapidly as it percolates through the till. The acidity of any seepage should decrease with distance from the RCRA impoundment as long as the buffering capacity of the natural system is not overwhelmed. Low flow rates and high buffering capacity should limit the movement of acidic water.

Based on this information, the RCRA monitoring well network will consist of two downgradient wells, OW-1 and 2, and one

Table 5. Estimated Potential for Waste Migration to Surface Water. U.S. Industrial Chemicals Co., Tuscola, Illinois.

$$Q = KIA$$

Where: Q = discharge, gpd
K = horizontal permeability, gpd/sq ft
I = gradient from OW-4 to OW-1
A = flow section of 30,000 sq ft

$$V = \frac{KI}{n}$$

Where: V = ground-water flow rate, ft/day
K = horizontal permeability, ft/day
n = formation porosity, 35%

$$\text{For } Kh:kv = 100:1$$

$$Q = (0.47)(0.0055)(30,000)$$

$$Q = 77.6 \text{ gpd}$$

$$V = \frac{(0.063)(0.0055)}{.35}$$

$$V = 0.001 \text{ ft/day}$$

upgradient well, OW-4 (Figure 4). These wells, drilled to a depth of thirty feet, consist of twenty feet of PVC well screen and ten to fifteen feet of PVC casing (Appendix 3). The screens are back-filled with clean quartz sand and the remaining annulus is sealed with cement/bentonite grout.

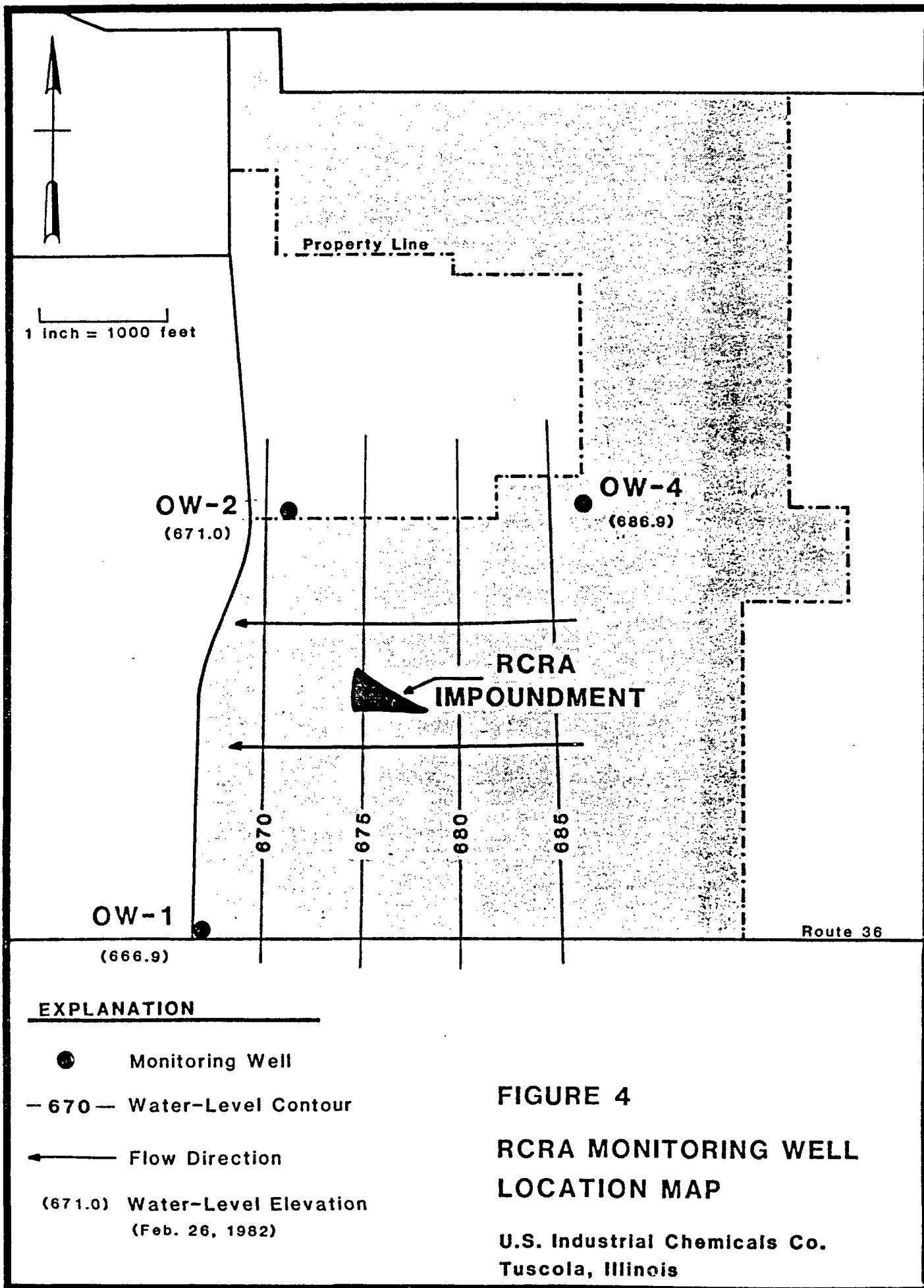
Sample Collection, Preservation and Shipment

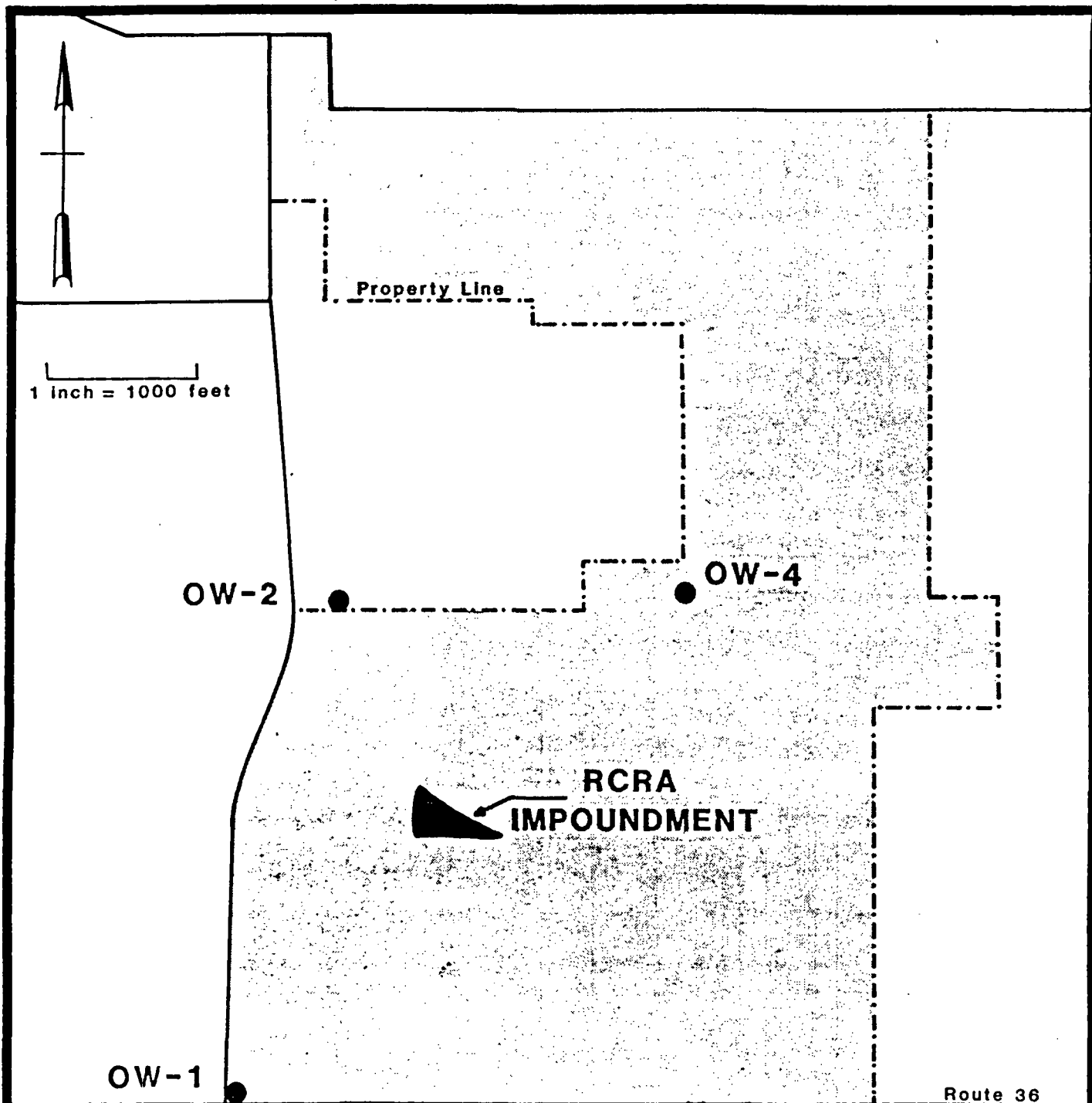
Water-quality samples will be collected quarterly for the first year and semiannually thereafter. The wells will be purged by removing at least one well volume with either a bailer, peristaltic pump, pitcher pump or some other suitable purging device. The purging method used will depend on the depth to water, well yield and the potential for cross contamination by the purging equipment. If well yield is too low to sustain continuous withdrawals, the well will be bailed dry and sampled after the water level recovers.

Purge volumes will be determined by measuring the depth to water in each well and calculating the standing water volume with the following formula:

$$V_w = V_c(D_c - D_w) \quad \text{where:} \quad \begin{array}{l} V_w = \text{standing water volume, gal} \\ V_c = \text{casing unit volume, gal/ft} \\ D_c = \text{total well depth, feet} \\ D_w = \text{depth to water, feet} \end{array}$$

Water samples will be collected with either a peristaltic pump or a bailer.



**EXPLANATION**

● Monitoring Well

FIGURE 4**RCRA MONITORING WELL
LOCATION MAP**

U.S. Industrial Chemicals Co.
Tuscola, Illinois

(Samples will be collected with a peristaltic pump by using the sample bottle as a vacuum flask. Polypropylene tubing was left in each well to prevent cross contamination by moving the same suction tube from well to well. Collecting the sample before it passes through the pump head will also prevent cross contamination.

(Samples may also be collected with a stainless steel bailer attached to new rope. Before each use, the bailer will be rinsed inside and out with distilled water at least four times. The bailer will then be lowered into the well, filled and dumped to waste four times before collecting a sample. On the fifth and subsequent bails, amber glass bottles of sufficient size for the water quality analyses will be filled.

All bottles will be prepared according to EPA protocol. Samples will be kept on ice from time of collection and hand carried to the plant laboratory where the proper preservatives, if any, will be added. Samples will be shipped to the selected commercial laboratory by the fastest transport means available.

Analytical Procedures

(Since the potential for impact by the waste management facility is low and the existing ground water is unsuitable for drinking water use (TDS greater than 500 mg/l), the water-quality parameters characterizing the suitability of a ground water as a drinking

(water source (265.92 b.1) and those establishing ground-water quality (265.92 b.2) are of little use in assessing the impact of the RCRA impoundment on ground-water quality. Therefore, water-quality samples will be analysed only for pH, specific conductance, total organic carbon and total organic halogen using EPA approved methods. If no significant levels of total organic halogen are found after the first year of sampling, TOX analyses will be suspended and total organic carbon will be used to detect organic contaminants.

To insure that samples do not become contaminated during collection and shipment, organic-free water blanks will be carried during sampling and shipped with the samples. Duplicate samples, spiked samples and spiked blanks will be used as necessary for analytical quality assurance.

Chain of Custody Control

At the time of collection, the following information will be recorded in a bound log book: sample identification number, date and time of collection, sample source, depth to water, preservative added and the analysis to be performed. The notebook will be signed and dated by the sampler. A water-proof label will be put on each sample bottle and marked with the sample identification number and the analysis to be performed. Each bottle will be sealed immediately after sample collection and preservation.

(Upon arrival at the laboratory, the sample custodian will log in the samples, recording in a bound log book the sample numbers,

the date and time of receipt and the condition of each sample and sample seal. Each entry will be signed and dated by the sample custodian. The samples will be stored in a locked area and distributed by the sample custodian or authorized representative to the laboratory personnel who will perform the analyses. The person receiving the samples will record the sample number, time of receipt and condition of the sample seal in a bound laboratory notebook and sign and date the entry.

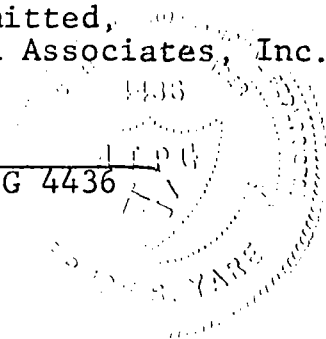
The entries into the permanently bound field notebook, log notebook and analyst notebook will constitute the chain of custody record.

Water-Quality Assessment Plan

If statistically significant water-quality degradation is observed in the downgradient wells, two to four shallow monitoring wells will be installed downgradient of the RCRA impoundment. Two wells will be installed in the direction of flow and two wells will be installed perpendicular to the direction of flow. Installation of these wells will confirm the presence and concentration of contaminants in the ground-water flow system and allow an evaluation of the rate and extent of migration of contaminants.

Respectfully Submitted,
Bruce S. Yare and Associates, Inc.

Bruce S. Yare
Bruce S. Yare, CPG 4436
President



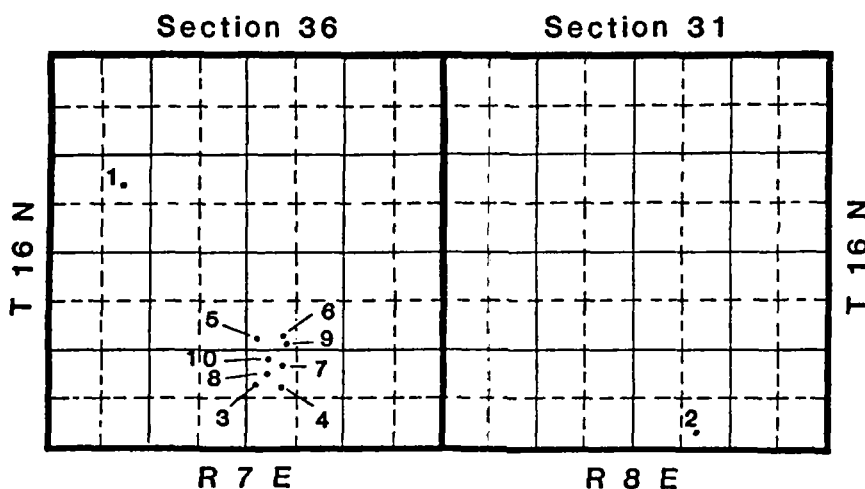
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APPENDIX 1

REPRESENTATIVE BORING LOGS

Appendix 1. Boring Location Map. U.S. Industrial Chemicals Co.,
Tuscola, Illinois (Data from Illinois State Geological
Survey files.)



Section 36, T16N, R7E

Boring No. 1 - 1952, NE, SW, NW
 Boring No. 3 - 1952, 740 ft. S. line, 50 ft. W. line SE $\frac{1}{4}$,
 Elev. 668.63 ft.
 Boring No. 4 - 1952, 840 ft. S. line, 500 ft. W. line SE $\frac{1}{4}$,
 Elev. 669.65 ft.
 Boring No. 5 - 1952, 1540 ft. S. line, 50 ft. W. line SE $\frac{1}{4}$,
 Elev. 668.8 ft.
 Boring No. 6 - 1952, 1540 ft. S. line, 520 ft. W. line SE $\frac{1}{4}$,
 Elev. 671.11 ft.
 Boring No. 7 - 1952, 1010 ft. S. line, 370 ft. W. line SE $\frac{1}{4}$,
 Elev. 669.3 ft.
 Boring No. 8 - 1952, 1006 ft. S. line, 294 ft. W. line SE $\frac{1}{4}$
 Boring No. 9 - 1952, 1437.5 ft. S. line, 386 ft. W. line SE $\frac{1}{4}$
 Boring No. 10 - 1953, 1040 ft. S. line, 490 ft. W. line SE $\frac{1}{4}$

Section 31, T16N, R8E

Boring No. 2 - 1952, SE, SW, SE

Appendix 1. Representative Boring Logs. U.S. Industrial Chemicals Co., Tuscola, Illinois. (Data from Illinois State Geological Survey files. Depths are in feet below ground surface.)

Boring No. 1

<u>Depth</u>	<u>Description</u>
0 - 2	TOPSOIL
2 - 10	TILL - yellowish orange
10 - 27	TILL - yellow
27 - 40	TILL - gray
40 - 45	TILL - very silty, orange
45 - 50	TILL - gray
50 - 65	TILL - gravelly, gray
65 - 85	TILL - very gravelly, yellow
85 - 90	TILL - silty, yellow to orange
90 - 110	TILL - gray
110 - 983	Pennsylvanian shale, siltstone, sandstone and limestone

Boring No. 2

<u>Depth</u>	<u>Description</u>
0 - 2	TOPSOIL
2 - 5	TILL - yellowish brown
5 - 38	TILL - gray
38 - 65	GRAVEL - silty, gray
65 - 70	TILL - gravelly, gray
70 - 90	SAND & GRAVEL - silty, gray
90 - 120	TILL - gravelly, brownish gray
120 - 205	TILL - sandy, olive gray
205 - 212	SILT - fossiliferous, brown to gray
212 - 242	TILL - gravelly, gray
242 - 781	Pennsylvanian shale, siltstone and limestone

Appendix 1. Representative Boring Logs. U.S. Industrial Chemicals Co., Tuscola, Illinois. (Continued)

Boring No. 3

<u>Depth</u>	<u>Description</u>
0 - 2	TOPSOIL
2 - 14	TILL - yellow
14 - 35	TILL - gray
35 - 40	TILL - olive gray
40 - 75	TILL - sandy, gravelly, gray
75 - 85	TILL - gray
85 - 100	TILL - gravelly, yellow
100 - 150	TILL - gravelly, buff
150 - 200	TILL - buff to gray
200 - 213	TILL - gravelly, buff to gray
213 - 440	Pennsylvanian shale, siltstone, sandstone and limestone

Boring No. 4

<u>Depth</u>	<u>Description</u>
0 - 2	TOPSOIL
2 - 15	TILL - yellow
15 - 50	TILL - gray
50 - 113	TILL - gravelly, brownish gray
113 - 130	TILL - buff
130 - 148	TILL - yellow
148 - 193	TILL - brownish gray
193 - 204	TILL - silty, brownish gray
204 - 451	Pennsylvanian shale, siltstone, sandstone and limestone

Appendix 1. Representative Boring Logs. U.S. Industrial Chemicals Co., Tuscola, Illinois. (Continued)

Boring No. 5

<u>Depth</u>	<u>Description</u>
0 - 1.5	TOPSOIL
1.5 - 20	TILL - yellow
20 - 45	TILL - gray
45 - 50	TILL - olive gray
50 - 90	TILL - brownish gray
90 - 105	TILL - yellow
105 - 135	TILL - brownish gray
135 - 160	TILL - yellow to brown
160 - 185	TILL - brownish gray
185 - 198	TILL - yellowish to brown
198 - 443	Pennsylvanian shale, siltstone, sandstone and limestone

Boring No. 6

<u>Depth</u>	<u>Description</u>
0 - 1.5	TOPSOIL
1.5 - 20	TILL - yellow
20 - 55	TILL - gray
55 - 90	TILL - brownish gray
90 - 103	TILL - yellowish brown
103 - 134	TILL - brownish gray
134 - 140	TILL - gray
140 - 165	TILL - very silty, yellow to buff
165 - 195	TILL - gray
195 - 208	TILL - brownish gray
208 - 450	Pennsylvanian shale, siltstone, sandstone and limestone

Appendix 1. Representative Boring Logs. U.S. Industrial Chemicals Co., Tuscola, Illinois. (Continued)

Boring No. 7

<u>Depth</u>	<u>Description</u>
0 - 1	TOPSOIL
1 - 38	TILL - Wisconsin, yellow to gray
38 - 73	TILL - Illinoian, brownish gray to gray
73 - 79	SAND & GRAVEL - slightly silty gray
79 - 123	TILL - Illinoian, orange brown to gray
123 - 128	SAND & GRAVEL - silty, brownish gray
128 - 147	TILL - Kansan, buff to gray
147 - 200	SILT - preglacial, clayey, sandy, gray mottled

Boring No. 8

<u>Depth</u>	<u>Description</u>
0 - 2	TOPSOIL
2 - 13	TILL - yellow
13 - 38	TILL - gray
38 - 45	SILT - yellow to dark brown
45 - 88	TILL - brownish gray
88 - 95	TILL - orange to brown
95 - 142	TILL - brownish gray
142 - 155	SILT - yellow to dark brown
155 - 200	SILT - brownish gray

Appendix 1. Representative Boring Logs. U.S. Industrial Chemicals Co., Tuscola, Illinois. (Continued)

Boring No. 9

<u>Depth</u>	<u>Description</u>
0 - 1	TOPSOIL
1 - 15	TILL - yellow
15 - 38	TILL - gray
38 - 40	TILL - yellow to brown
40 - 45	TILL - gray
45 - 50	SILT - brownish gray
50 - 60	TILL - gray
60 - 90	TILL - brownish gray
90 - 105	TILL - brown
105 - 165	TILL - gravelly, brownish gray
165 - 203	SILT - yellow to gray

Boring No. 10

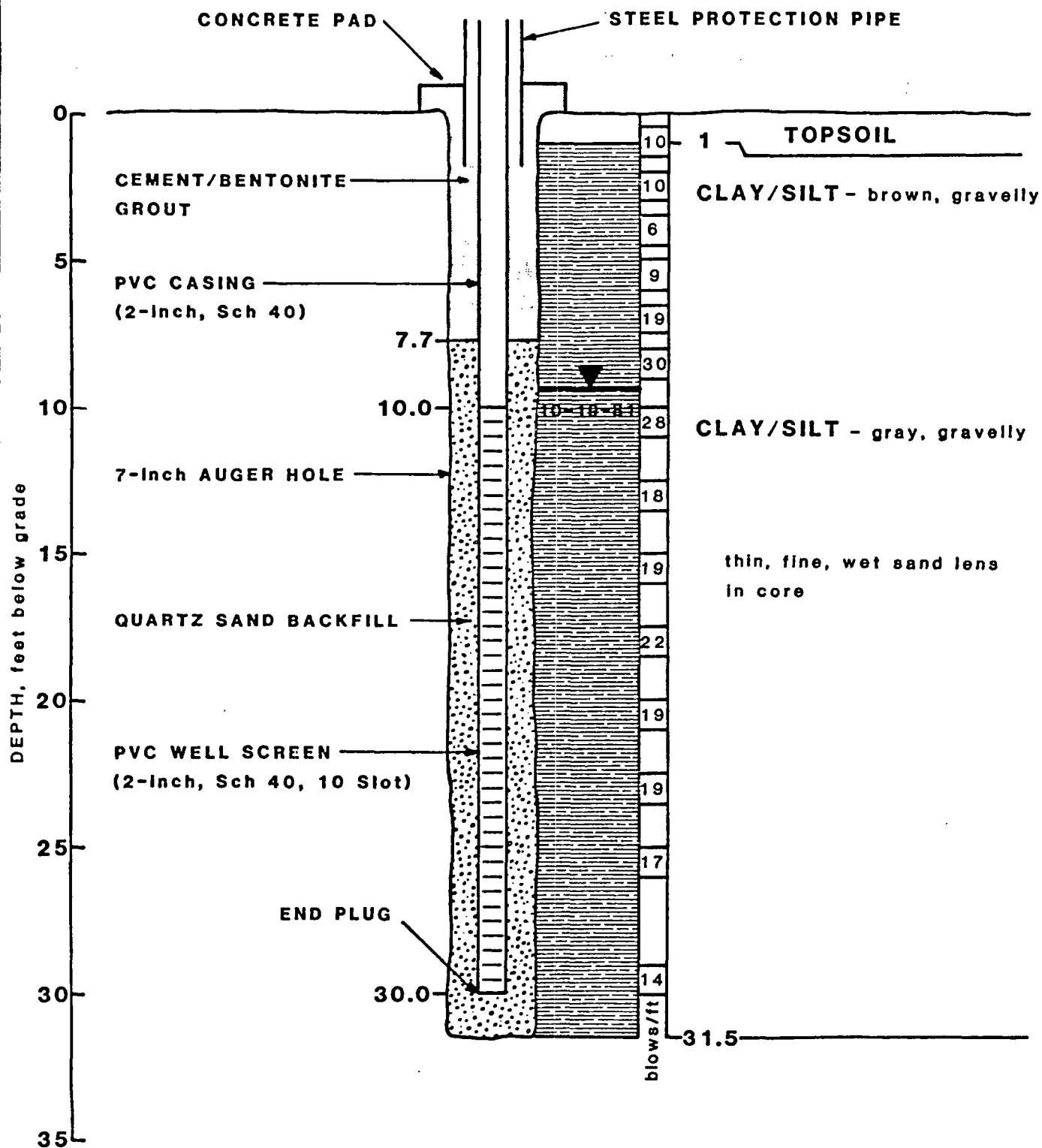
<u>Depth</u>	<u>Description</u>
0 - 10	TILL - slightly sandy, yellow
10 - 35	TILL - gray
35 - 40	TILL - clayey, yellowish green
40 - 55	TILL - silty, gray
55 - 64	TILL - sandy, gravelly, gray
64 - 72	TILL - very clayey, gray
72 - 73	GRAVEL - fine to medium, sand
73 - 80	TILL - very clayey, gray
80 - 81	GRAVEL - fine to medium, sand
81 - 89	TILL - silty, gray
89 - 100	TILL - light brown
100 - 127	TILL - very silty, light brown
127 - 140	SAND - fine, silty, clayey
140 - 153	SILT - light buff

Appendix 2. Observation Well Construction Summary. U.S. Industrial Chemicals Co., Tuscola, Illinois. (All measurements in feet below ground surface unless otherwise noted. Elevation in feet above mean sea level and height of measuring point in feet above grade.)

<u>Well</u>	<u>Size</u> (in)	<u>Total</u> <u>Depth</u> (ft)	<u>Screened</u> <u>Interval</u> (ft)	<u>Measuring Point</u>			<u>Installed</u>
				<u>M.P.</u> (ft)	<u>Elev.</u> (ft)	<u>Height</u> (ft)	
OW-1	2	30.0	10.0 - 30.0	TOC	674.78	3.2	8-31-81
OW-2	2	29.9	10.0 - 29.9	TOC	681.49	3.2	9-2-81
OW-3	2	30.1	10.2 - 30.1	TOC	685.74	3.2	9-3-81
OW-4	2	29.4	9.4 - 29.4	TOC	695.05	3.3	9-1-81
OW-5	2	30.1	10.2 - 30.1	TOC	696.95	3.1	9-3-81
OW-6	2	30.0	10.0 - 30.0	TOC	693.57	3.0	9-3-81
OW-7	2	29.7	9.8 - 29.7	TOC	691.69	3.2	9-3-81

APPENDIX 3

WELL CONSTRUCTION DIAGRAMS



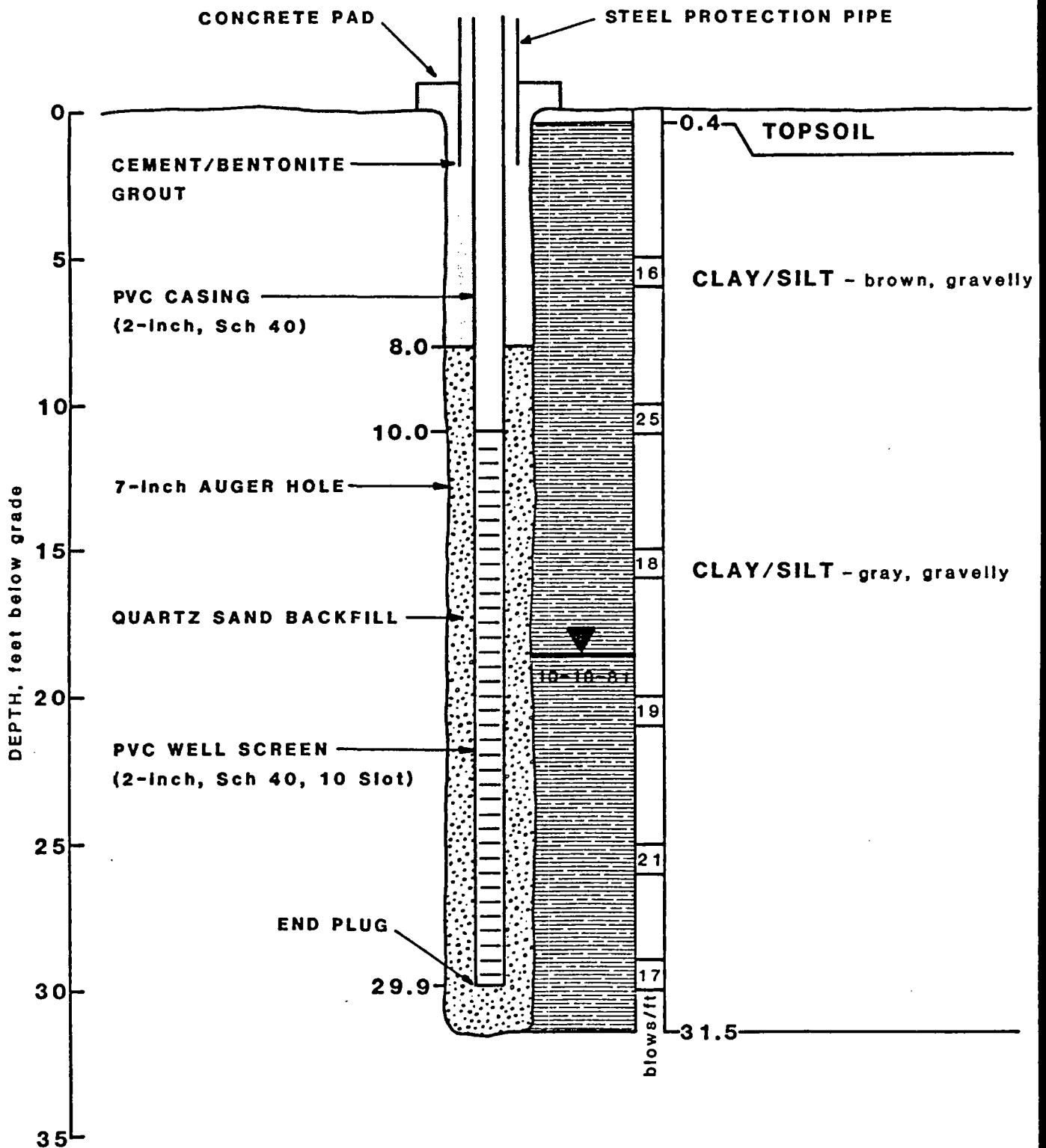
NOTES:

- 1) Installed 8-31-81
- 2) Flush threaded joints
- 3) TOC elevation 674.78 ft msl
- 4) TOC is 3.2 ft above grade

APPENDIX 3

OW-1 CONSTRUCTION DIAGRAM

U.S. INDUSTRIAL CHEMICALS CO.
TUSCOLA, ILLINOIS



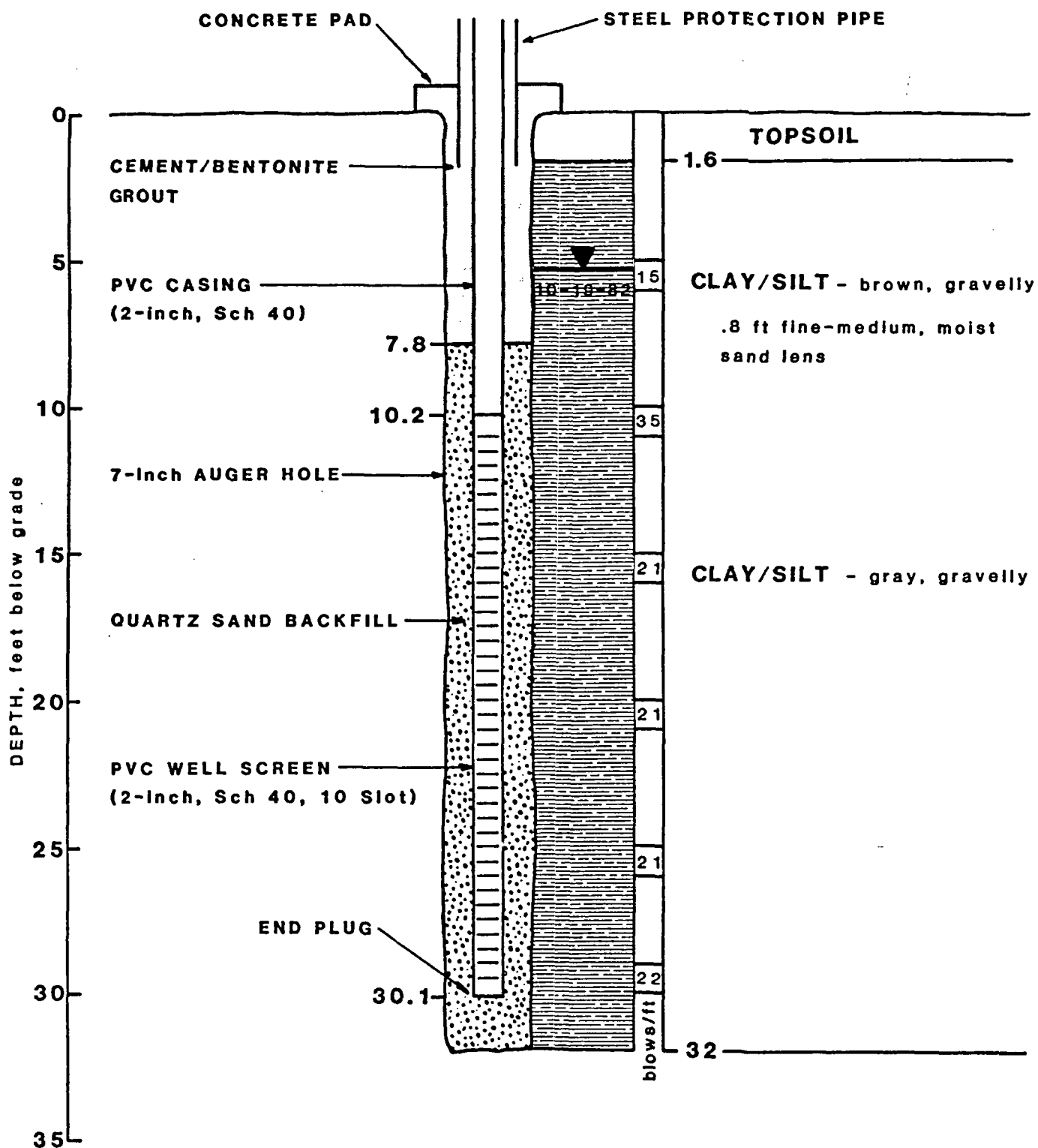
NOTES:

- 1) Installed 9-2-82
- 2) Flush threaded joints
- 3) TOC elevation 681.49 ft msl
- 4) TOC is 3.2 feet above grade

APPENDIX 3

OW-2 CONSTRUCTION DIAGRAM

U.S. INDUSTRIAL CHEMICALS CO.
TUSCOLA, ILLINOIS



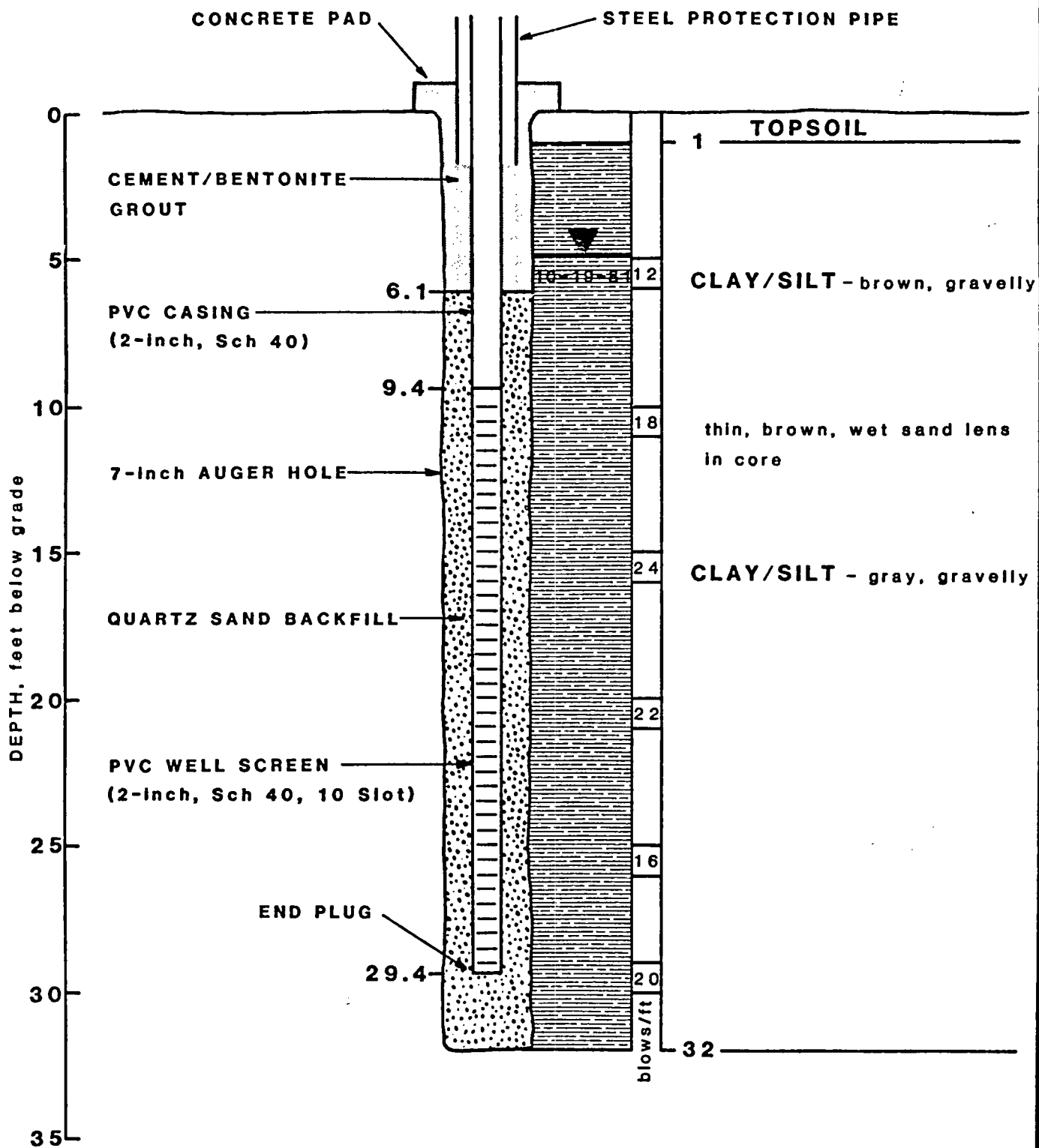
NOTES:

- 1) Installed 9-3-81
- 2) Flush threaded joints
- 3) TOC elevation 685.74 ft msl
- 4) TOC is 3.2 ft above grade

APPENDIX 3

OW-3 CONSTRUCTION DIAGRAM

U.S. INDUSTRIAL CHEMICALS CO.
TUSCOLA, ILLINOIS



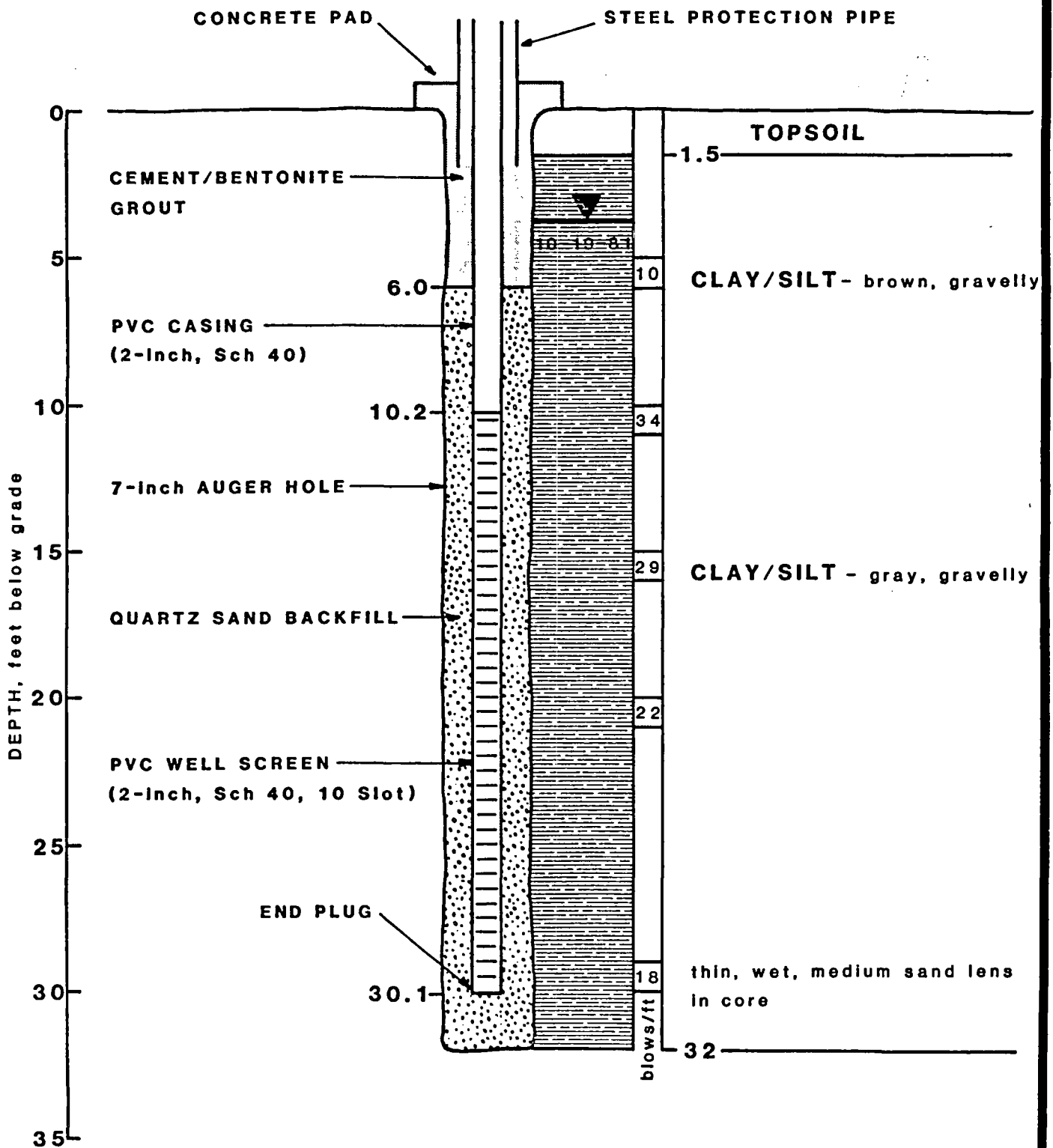
NOTES:

- 1) Installed 9-1-81
- 2) Flush threaded joints
- 3) TOC elevation 695.05 ft msl
- 4) TOC is 3.3 feet above grade

APPENDIX 3

OW-4 CONSTRUCTION DIAGRAM

U.S. INDUSTRIAL CHEMICALS CO.
TUSCOLA, ILLINOIS



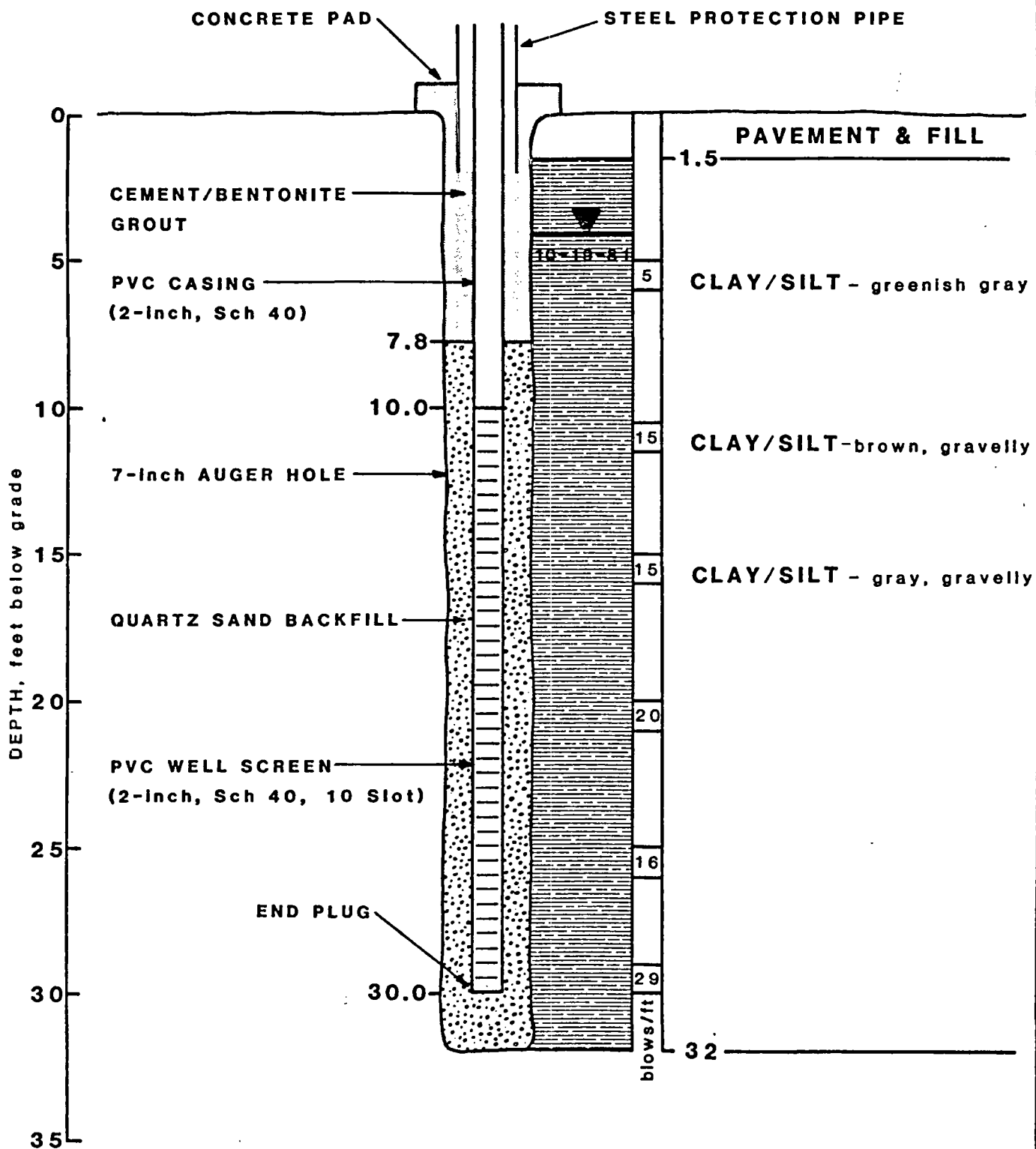
NOTES:

- 1) Installed 9-3-81
- 2) Flush threaded joints
- 3) TOC elevation 696.95 ft msl
- 4) TOC is 3.1 feet above grade

APPENDIX 3

OW-5 CONSTRUCTION DIAGRAM

U.S. INDUSTRIAL CHEMICALS CO.
TUSCOLA, ILLINOIS



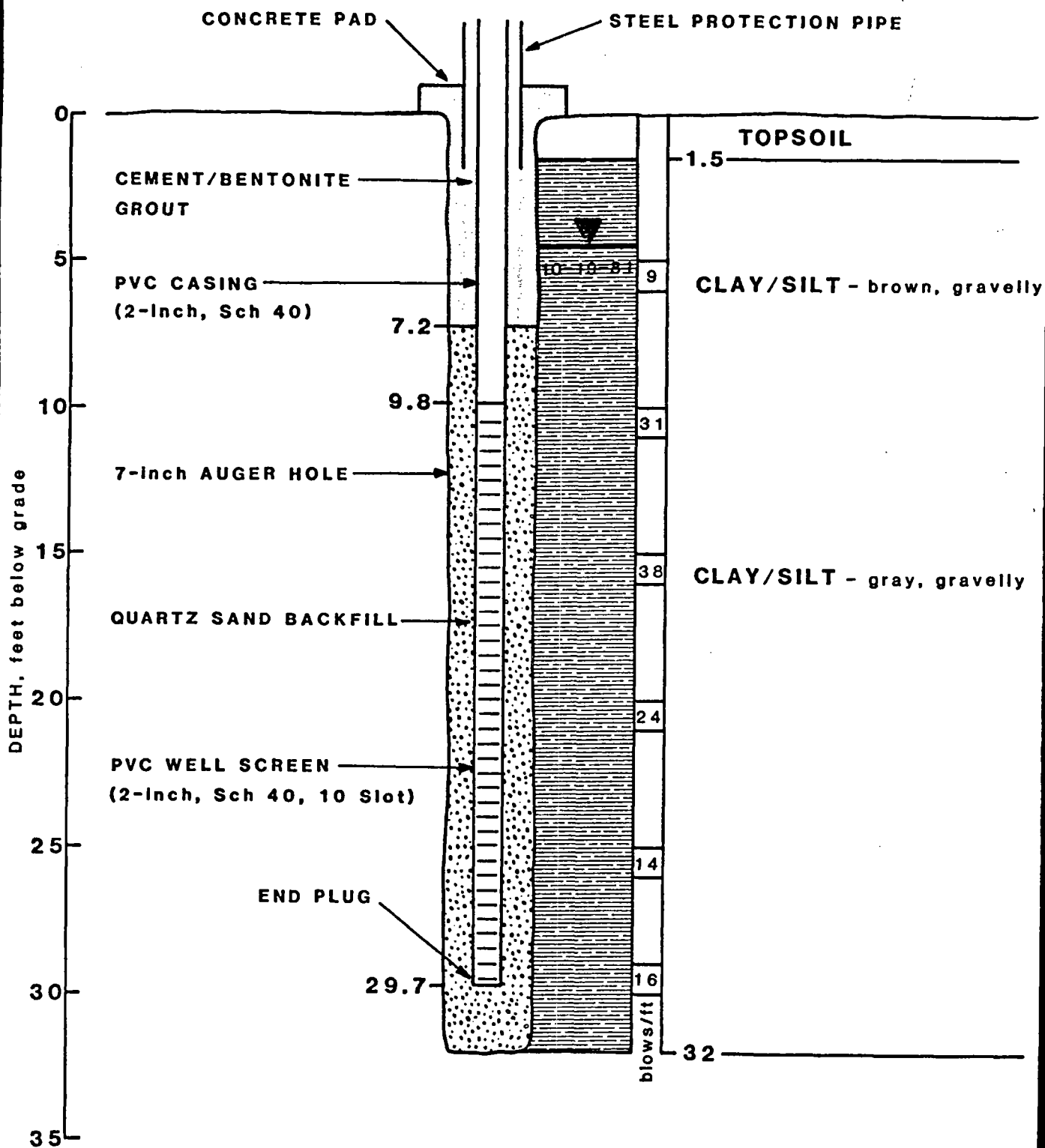
NOTES:

- 1) Installed 9-1-81
- 2) Flush threaded joints
- 3) TOC elevation 693.57 ft msl
- 4) TOC is 3.0 feet above grade

APPENDIX 3

OW-6 CONSTRUCTION DIAGRAM

U.S. INDUSTRIAL CHEMICALS CO.
TUSCOLA, ILLINOIS



NOTES:

- 1) Installed 9-3-81
- 2) Flush threaded joints
- 3) TOC elevation 691.69 ft msl
- 4) TOC is 3.2 feet above grade

APPENDIX 3

OW-7 CONSTRUCTION DIAGRAM

U.S. INDUSTRIAL CHEMICALS CO.
TUSCOLA, ILLINOIS

APPENDIX 4

UNCONSOLIDATED SEDIMENT PHYSICAL CHARACTERISTICS



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 & ASSOCIATES, INC. CONSULTING ENGINEERS

SOIL CLASSIFICATION AND ENGINEERING PROPERTIES

2900 N. Broadway • P.O. Box 2233 • Decatur, Illinois, 62526 • 217/877-2100

PROJECT: Observation Well Program
 U.S. Industrial Chemicals Co.
 Tuscola, Illinois

JOB NO. 11720

DATE: September 22, 1981

BORING/SAMPLE NO'S.		2/2	2/6	5/2	5/7	
DEPTH/ FT.		7½ - 9½	21 - 23	7½ - 9½	23 - 25	
SOIL PARTICLE SIZES						
GRAVEL; %		2	4	5	5	
SAND; %		24	29	26	27	
coarse %		2	2	2	2	
medium %		6	8	6	6	
fine %		16	19	18	19	
FINES; %		74	67	69	68	
silt %		46	48	45	45	
clay %		28	19	24	23	
PLASTICITY CHARACTERISTICS						
MOISTURE CONTENT %		14	14	14	13	
LIQUID LIMIT		--	--	--	--	
PLASTIC LIMIT		--	--	--	--	
PLASTICITY INDEX		--	--	--	--	
CLASSIFICATION						
USCS		Brown CL	Gray CL	Brown CL	Gray CL	
USDA/AASHTO		--	--	--	--	
ENGINEERING PROPERTIES						
UNIT DRY DENSITY; pcf		123.0	122.0	123.0	125.0	
OPT. MOISTURE CONTENT; %		--	--	--	--	
BEARING RATIO		--	--	--	--	
PERMEABILITY, cm/sec		7.1×10^{-9}	1.1×10^{-8}	8.2×10^{-9}	2.0×10^{-8}	



& ASSOCIATES

CONSULTING ENGINEERS



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 & ASSOCIATES, INC. CONSULTING ENGINEERS

**SOIL CLASSIFICATION AND
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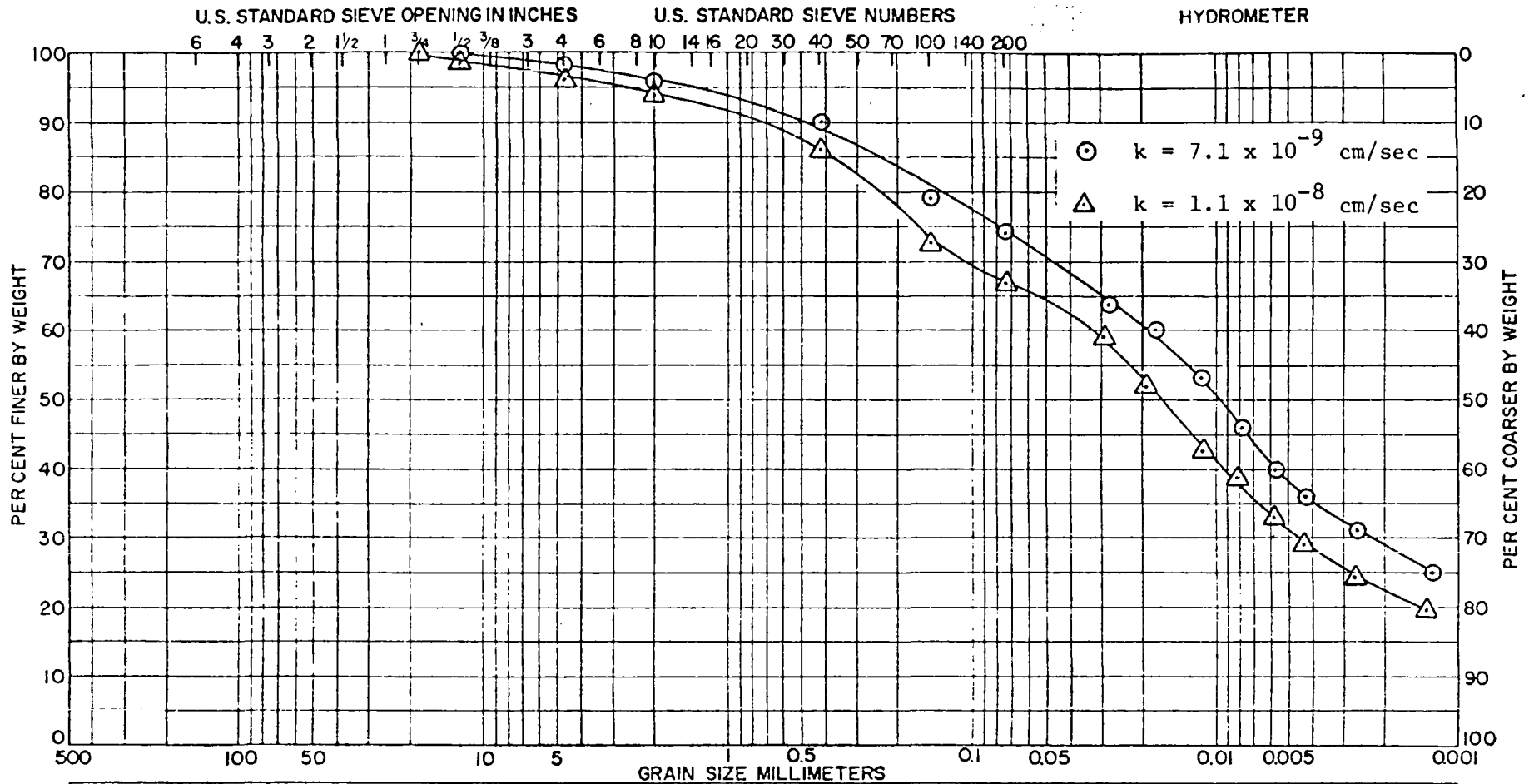
BORING/SAMPLE NO'S.	6/2	6/6			
DEPTH/FT.	8 - 10	21 - 23			
SOIL PARTICLE SIZES					
GRAVEL; %	3	2			
SAND; %	26	26			
coarse %	2	1			
medium %	4	2			
fine %	20	23			
FINES; %	71	72			
silt %	43	48			
clay %	28	24			
PLASTICITY CHARACTERISTICS					
MOISTURE CONTENT %	14	14			
LIQUID LIMIT	--	--			
PLASTIC LIMIT	--	--			
PLASTICITY INDEX	--	--			
CLASSIFICATION					
USCS	Brown CL	Gray CL			
USDA/AASHTO	--	--			
ENGINEERING PROPERTIES					
UNIT DRY DENSITY; pcf	123.0	123.0			
OPT. MOISTURE CONTENT; %	--	--			
BEARING RATIO	--	--			
PERMEABILITY, cm/sec	2.4 X10 ⁻⁸	7.1 X10 ⁻⁹			



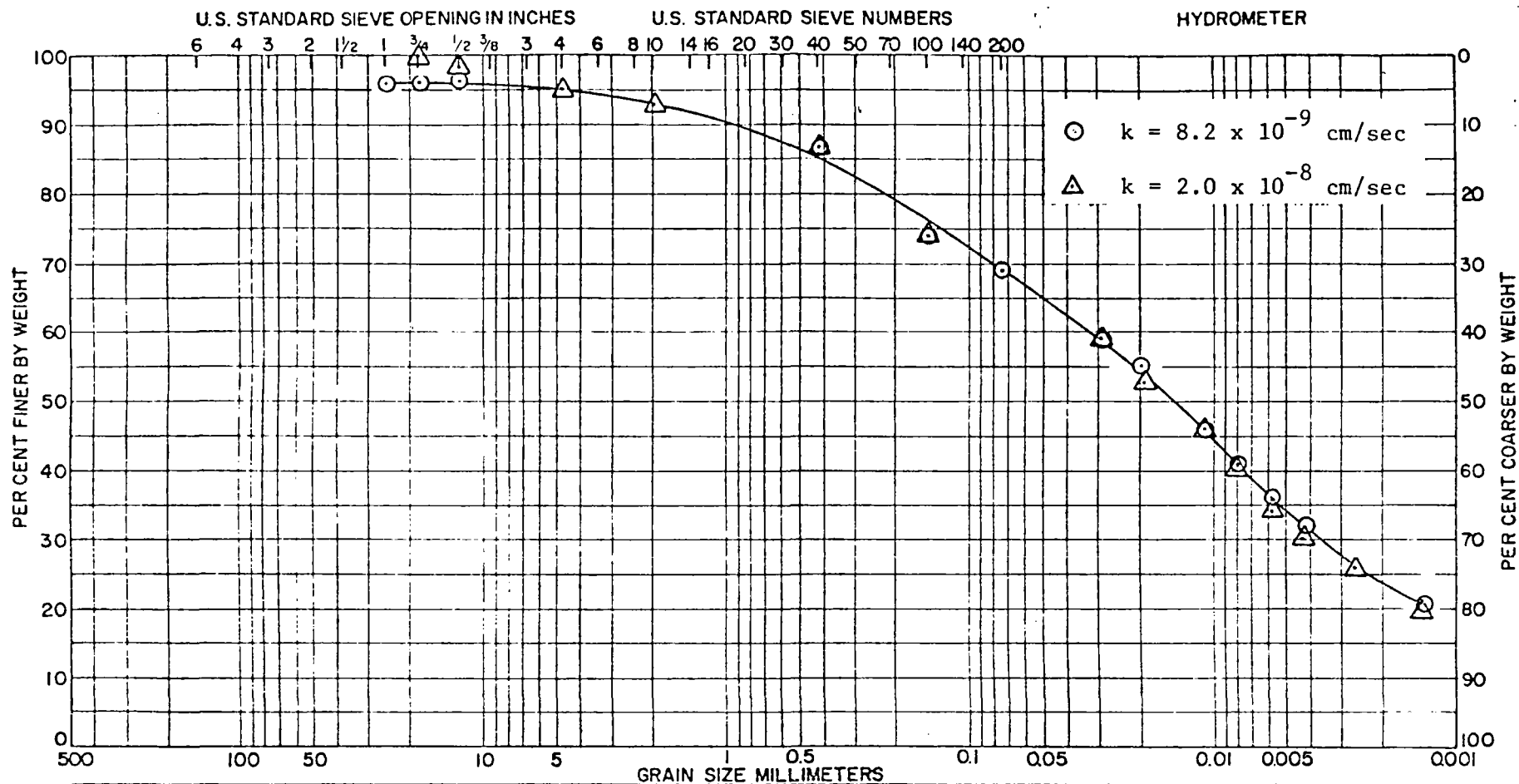
& ASSOCIATES

CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION



GRAIN SIZE DISTRIBUTION



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

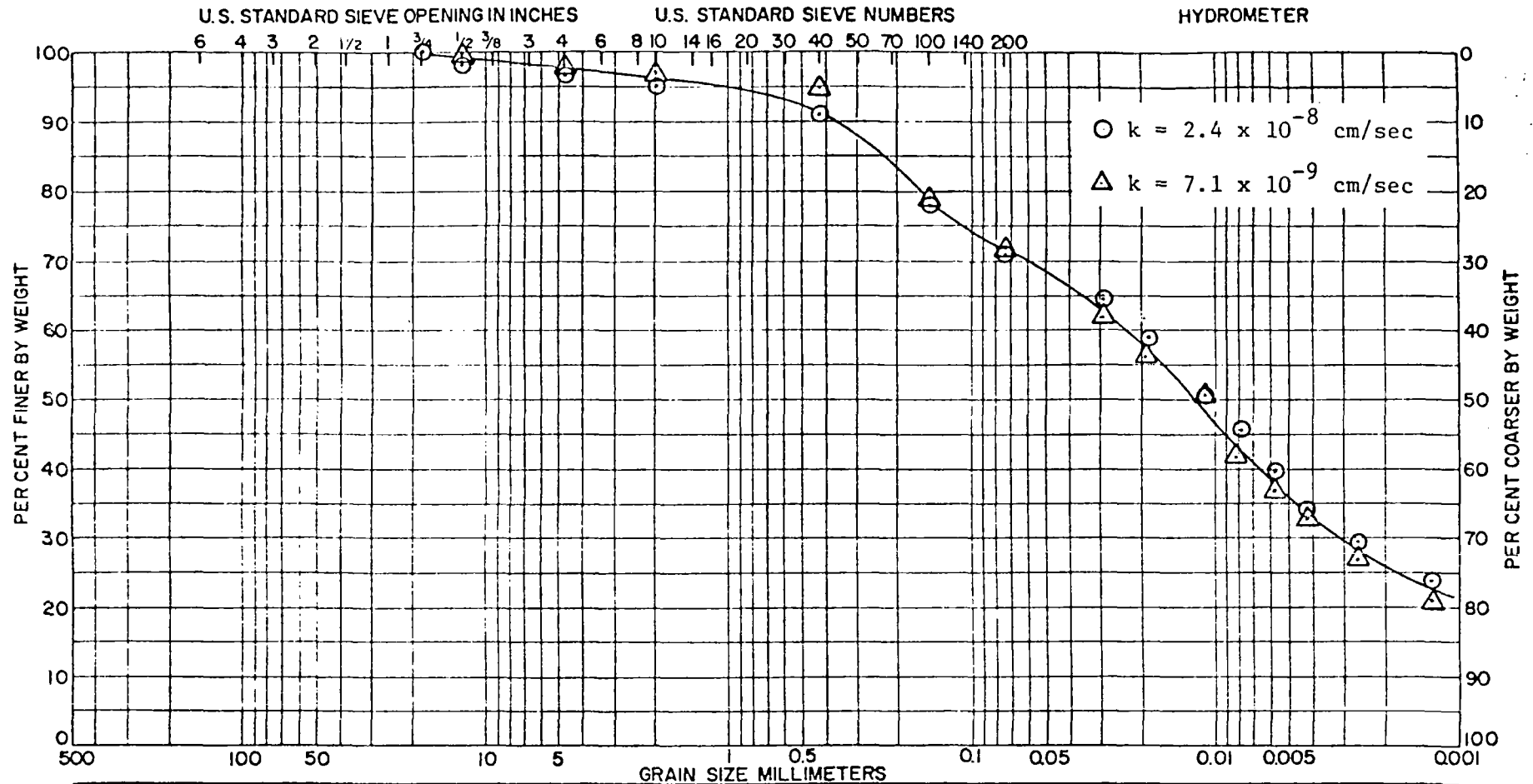
BORING NO.	SAMPLE NO.	SYMBOL	ELEV./DEPTH	USC	DESCRIPTION	NAT. W%	LL	PL	PI
5	2	○	7 1/2 - 9 1/2	CL	Brown low plasticity silty clay, some sand, trace gravel	14	--	--	--
5	7	△	23-25	CL	Gray low plasticity silty clay, some sand, trace gravel	14	--	--	--

OBSERVATION WELL PROGRAM
U.S. INDUSTRIAL CHEMICALS CO.
TUSCOLA, ILLINOIS

PROJ. NO. 11720

SKS shaffer·krimmel·silver
ASSOCIATES, INC. CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION



BORING NO.	SAMPLE NO.	SYMBOL	ELEV./DEPTH	USC	DESCRIPTION	NAT. W%	LL	PL	PI
6	2	○	8-10	CL	Brown low plasticity silty clay, some sand, trace gravel	14	--	--	--
6	6	△	21-23	CL	Gray low plasticity silty clay, some sand, trace gravel	14	--	--	--

SHAFFER, KRIMMEL, SILVER & ASSOCIATES, INC.

ION-EXCHANGE CAPACITY TEST RESULTS
 OBSERVATION WELL PROGRAM
 U.S. INDUSTRIAL CHEMICALS CO.
 TUSCOLA, ILLINOIS
 PROJECT NO. 11720

Boring No.	Sample No.	Depth Ft.	Ion-Exchange Capacity Milliequivalents per 100 grams			Acidity Ph
			K	Ca	Mg	
2	2	7½-9½	0.2	80	20	7.5
2	6	21-23	0.3	82	18	8.0
5	2	7½-9½	0.1	83	17	7.9
5	7	23-25	0.2	84	16	8.0
6	2	8-10	0.1	85	15	7.8
6	6	21-23	0.1	83	17	7.8

Notes

1. The exchangeable hydrogen ion capacity is zero in all samples, and the sodium ion capacity for Central Illinois soils is generally less than 0.1 MEQ.
2. These tests were performed by Sparks Testing Laboratories, Lincoln, Illinois.

APPENDIX 5

FIELD PERMEABILITY TESTS

Appendix 5. Analysis of Falling Head Permeability Test Data.
 U.S. Industrial Chemicals Co., Tuscola, Illinois.
 (Analytical method from Winterkorn, H.F. and Fang,
 H.F., 1975. Foundation Engineering Handbook: Van
 Nostrand Reinhold, New York, p. 32.)

$$K_h = \frac{d^2 \cdot \ln\left(\frac{2mL}{D}\right)}{8 \cdot L \cdot (t_2 - t_1)} \ln \frac{H_1}{H_2} \quad \text{for } \frac{mL}{D} > 4$$

Where: K_h = horizontal permeability, cm/sec

d = well diameter, cm

m = transformation ratio = $\sqrt{k_h/k_v}$

L = screen length, cm

D = screen diameter, cm

H_1 = water level at t_1 , cm

H_2 = water level at t_2 , cm

t = time, seconds

Well	$d = D$ (cm)	L (cm)	Time (sec)	Water Level (cm)	Horizontal Permeability (cm/sec)		
					$\frac{k_h:k_v}{1:1}$	$\frac{k_h:k_v}{100:1}$	$\frac{k_h:k_v}{1000:1}$
OW-2	5.08	597.4	300	24.4	1.57×10^{-5}	2.22×10^{-5}	2.55×10^{-5}
			3600	141.4			
OW-5	5.08	597.4	300	121.0	0.49×10^{-5}	0.69×10^{-5}	0.80×10^{-5}
			3600	208.8			
OW-6	5.08	597.4	300	42.4	1.34×10^{-5}	1.89×10^{-5}	2.18×10^{-5}
			3600	190.5			

Appendix 5. Analysis of Falling Head Permeability Test Data.
 U.S. Industrial Chemicals Co., Tuscola, Illinois
 (Analytical method from Schmid, W.E., 1967. Field
 Determination of Permeability by the Infiltration
 Test: Permeability and Capillarity of Soils, ASTM
 STP417, p. 146.)

$$K = \frac{d^2}{4(d+b)} \ln \frac{H_1}{H_2} \frac{1}{(t_2 - t_1)}$$

Where: K = permeability, cm/sec

d = well diameter, cm

b = $\frac{1}{2}$ screen length, cm

H₁ = water level at t₁, cm

H₂ = water level at t₂, cm

t = time, seconds

<u>Well</u>	<u>d</u> (cm)	<u>L</u> (cm)	<u>Time</u> (sec)	<u>Water Level</u> (cm)	<u>Permeability</u> (cm/sec)
OW-2	5.08	597.4	300	24.4	1.12x10 ⁻⁵
			3600	141.4	
OW-5	5.08	597.4	300	121.0	0.35x10 ⁻⁵
			3600	208.8	
OW-6	5.08	597.4	300	42.4	0.95x10 ⁻⁵
			3600	190.5	

Appendix 5. Observation Well OW-2 Falling Head Permeability Test.
 U.S. Industrial Chemicals Co., Tuscola, Illinois.
 (All measurements in feet below top of casing.)

Date	Elapsed		Date	Elapsed	
<u>Time</u>	<u>Time</u>	<u>DTW</u>	<u>Time</u>	<u>Time</u>	<u>DTW</u>
	(minutes)	(feet)		(minutes)	(feet)
10-21-81			10-21-81		
			(cont.)		
1001 am	-	29.54		16	2.01
1005 am	0.0	0.00		17	2.11
	0.5	-		18	2.20
	1.0	0.21		19	2.29
	1.5	0.30		20	2.38
	2.0	0.33		21	2.47
	2.5	0.42		22	2.51
	3.0	0.51		23	2.65
	3.5	0.59		24	2.71
	4.0	0.66		25	2.78
	4.5	0.72		26	2.84
	5.0	0.80		27	2.93
	5.5	0.86		28	3.00
	6.0	0.93		29	3.05
	6.5	0.99		30	3.12
	7.0	1.07		35	3.43
	7.5	-		40	3.73
	8.0	1.18		45	3.99
	8.5	1.24		50	4.23
	9.0	1.29		55	4.45
	9.5	1.35	1105 am	60	4.64
	10	1.41			
	11	1.49			
	12	1.62			
	13	1.72			
	14	1.82			
	15	1.92			

Appendix 5. Observation Well OW-5 Falling Head Permeability Test.
 U.S. Industrial Chemicals Co., Tuscola, Illinois
 (All measurements in feet below top of casing.)

<u>Date</u> <u>Time</u>	<u>Elapsed</u> <u>Time</u> (minutes)	<u>DTW</u> (feet)	<u>Date</u> <u>Time</u>	<u>Elapsed</u> <u>Time</u> (minutes)	<u>DTW</u> (feet)
10-21-81			10-21-81 (cont.)		
839 am	-	6.94		16	6.09
843 am	0.0	0.00		17	6.19
	0.5	0.59		18	6.25
	1.0	1.13		19	6.32
	1.5	1.73		20	6.37
	2.0	2.12		21	6.42
	2.5	2.61		22	6.46
	3.0	2.95		23	6.49
	3.5	3.25		24	6.53
	4.0	3.51		25	6.56
	4.5	3.77		26	6.58
	5.0	3.97		27	6.61
	5.5	4.11		28	6.63
	6.0	4.36		29	6.65
	6.5	4.46		30	6.67
	7.0	4.62		35	6.75
	7.5	4.80		40	6.79
	8.0	4.94		45	6.80
	8.5	5.06		50	6.83
	9.0	5.17		55	6.85
	9.5	5.28	0943 am	60	6.85
	10	5.37			
	11	5.54			
	12	5.68			
	13	5.81			
	14	5.92			
	15	5.99			

Appendix 5. Observation Well OW-6 Falling Head Permeability Test.
 U.S. Industrial Chemicals Co., Tuscola, Illinois
 (All measurements in feet below top of casing.)

<u>Date</u> <u>Time</u>	<u>Elapsed</u> <u>Time</u> (minutes)	<u>DTW</u> (feet)	<u>Date</u> <u>Time</u>	<u>Elapsed</u> <u>Time</u> (minutes)	<u>DTW</u> (feet)
10-21-81			10-21-81 (cont.)		
1117 am	-	7.09		16	3.29
1119 am	0.0	0.00		17	3.44
	0.5	0.24		18	3.55
	1.0	0.37		19	3.69
	1.5	0.52		20	3.80
	2.0	0.67		21	3.93
	2.5	0.81		22	4.04
	3.0	0.94		23	4.11
	3.5	1.07		24	4.21
	4.0	1.19		25	4.34
	4.5	1.31		26	4.43
	5.0	1.39		27	4.53
	5.5	1.51		28	4.60
	6.0	1.62		29	4.71
	6.5	1.73		30	4.78
	7.0	1.83		35	5.17
	7.5	1.92		40	5.47
	8.0	2.02		45	5.75
	8.5	2.12		50	5.97
	9.0	2.21		55	6.13
	9.5	-	1219 pm	60	6.25
	10	2.37			
	11	2.54			
	12	2.71			
	13	2.89			
	14	3.01			
	15	3.17			

Appendix 6. Domestic Well Logs. U.S. Industrial Chemicals Co., Tuscola, Illinois. (Data from Illinois State Water Survey files for T16N, R7E. All depths in feet below ground surface)

L. Joseph (SW, NE, Sec.?)

<u>DEPTH</u>	<u>DESCRIPTION</u>	<u>CONSTRUCTION INFORMATION</u>
1 - 18	TOPSOIL & CLAY, yellow	Date: 1957
18 - 42	CLAY, gray	Casing: --
42 - 46	HARDPAN	Screen: 5 ft. of 4 in, 20 Slot
46 - 53	?	Johnson brass
53 - 57	CLAY, gray	SWL: 24 ft.
57 - 83	HARDPAN, gray	PWL: --
83 - 93	SAND & GRAVEL	Yield: 15 gpm
		Duration: --

D. Cole (160 ft. N, 100 ft. E, SW corner, SE, SW, SW, Sec. 25)

<u>DEPTH</u>	<u>DESCRIPTION</u>	<u>CONSTRUCTION INFORMATION</u>
0 - 42	CLAY	Date: June 15, 1979
42 - 49	SAND	Casing: 4 in., 0 to 63 ft.
49 - 62	CLAY, blue	Screen: 4 ft. of 2½ in., 15 Slot
62 - 67	SAND & GRAVEL	SWL: 2 ft.
		PWL: 22 ft.
		Yield: 7 gpm
		Duration: 2 hours

J. Yoder (SE corner, SW, SW, Sec. 25)

<u>DEPTH</u>	<u>DESCRIPTION</u>	<u>CONSTRUCTION INFORMATION</u>
0 - 36	CLAY	Date: April 11, 1977
30 - 70	HARDPAN	Casing: 4 in., 0 - 71 ft.
70 - 75	GRAVEL	Screen: 4 ft., of 3 in., 20 Slot
		SWL: 6 ft.
		PWL: 19 ft.
		Yield: 10 gpm
		Duration: 1 hour

Appendix 6. Domestic Well Logs. U.S. Industrial Chemicals Co.,
Tuscola, Illinois: (Continued)

J. Most (SW corner, SW, SW, Sec. 25)

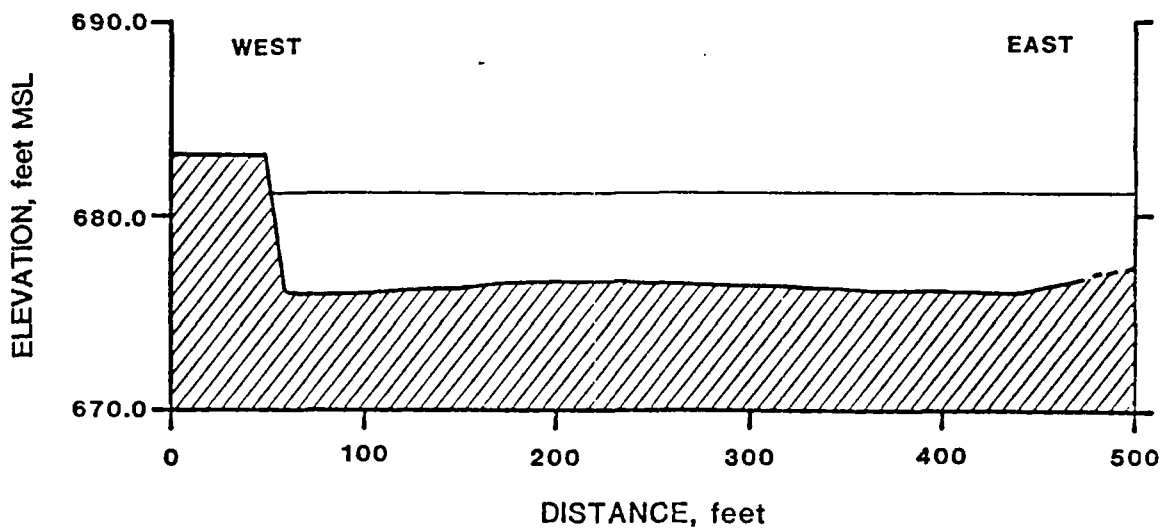
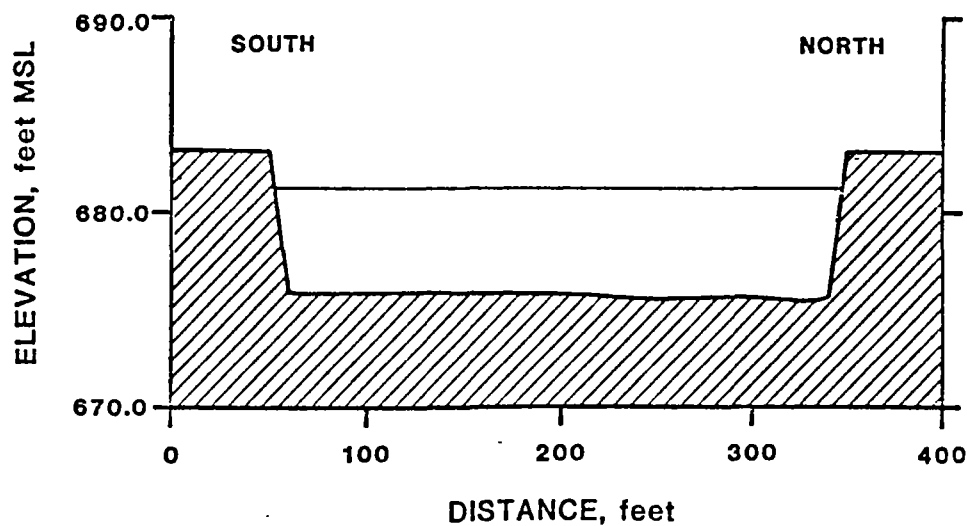
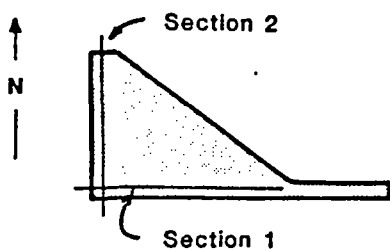
<u>DEPTH</u>	<u>DESCRIPTION</u>	<u>CONSTRUCTION INFORMATION</u>
0 - 78	CLAY	Date: March 24, 1977
78 - 84	SAND & GRAVEL	Casing: 4 in., 0 - 80 ft.
		Screen: 4 ft. of 2 in., 15 Slot
		SWL: 14 ft.
		PWL: 24 ft.
		Yield: 7 gpm
		Duration: 2 hours

E. Marsh (75 ft. N, 100 ft. W SE corner, SE, SW, Sec. 36)

<u>DEPTH</u>	<u>DESCRIPTION</u>	<u>CONSTRUCTION INFORMATION</u>
0 - 15	TOPSOIL & CLAY, yellow	Date: 1976
15 - 35	CLAY, gray	Casing: 4 in., 0 - 76 ft.
35 - 41	CLAY, green	Screen: 4 ft. of 4 in., 20 Slot
41 - 45	CLAY, brown	SWL: 10 ft.
45 - 70	HARDPAN, brown	PWL: 29 ft.
70 - 80	SAND, fine to coarse	Yield: 12 gpm
		Duration: 2 hours

Bache Chapel (450 ft. N, 1100 ft. E SW corner, SW, Sec. 36)

<u>DEPTH</u>	<u>DESCRIPTION</u>	<u>CONSTRUCTION INFORMATION</u>
0 - 15	TOPSOIL & CLAY, yellow	Date: May 10, 1972
15 - 25	CLAY, gray	Casing: 6 in., 0 - 64 ft.
25 - 30	CLAY, sandy, green	Screen: 4 ft of 6 in., 10 Slot
30 - 45	CLAY, very sandy, blue	SWL: 4 ft.
45 - 64	CLAY, sandy, hard, blue	PWL: 50 ft.
64 - 68	SAND	Yield: 10 gpm
68 - 72	CLAY, sandy, hard	Duration: 24 hours

SECTION 1SECTION 2PLAN VIEW

NOTE: Profiles are approximate and should not be used for design.

APPENDIX 7**RCRA IMPOUNDMENT SECTIONS**

U.S. INDUSTRIAL CHEMICALS CO.
TUSCOLA, ILLINOIS

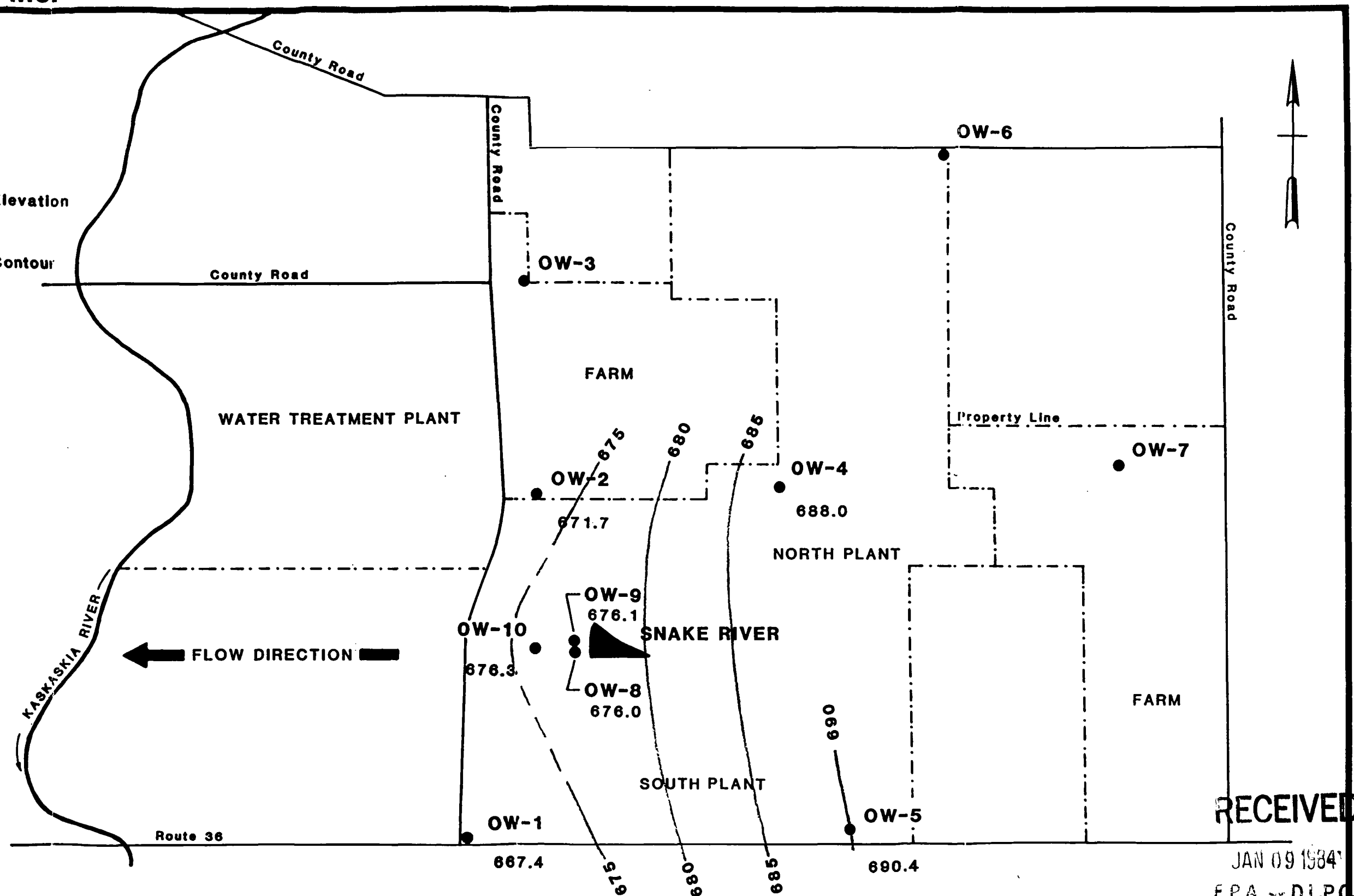
Explanation

- OW-1 Well Number
- 600.0 Water-Level Elevation
- 600 — Water-Level Contour

WELL	ELEVATION	
	GRADE	TOC
OW-1	671.6	674.8
OW-2	678.3	681.5
OW-3	682.5	685.7
OW-4*	691.7	695.0
OW-5	693.9	697.0
OW-6	690.6	693.6
OW-7	688.5	691.7
OW-8*	676.6	679.6
OW-9*	676.2	679.4
OW-10*	677.1	680.2

* RCRA Monitoring Well

1 Inch = 1000 feet



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JAN 09 1984

E.P.A. - D.L.P.C.
STATE OF ILLINOIS

GROUND-WATER ELEVATION AND FLOW DIRECTION

December 1983 Water Levels

U.S. Industrial Chemicals Company, Tuscola, Illinois